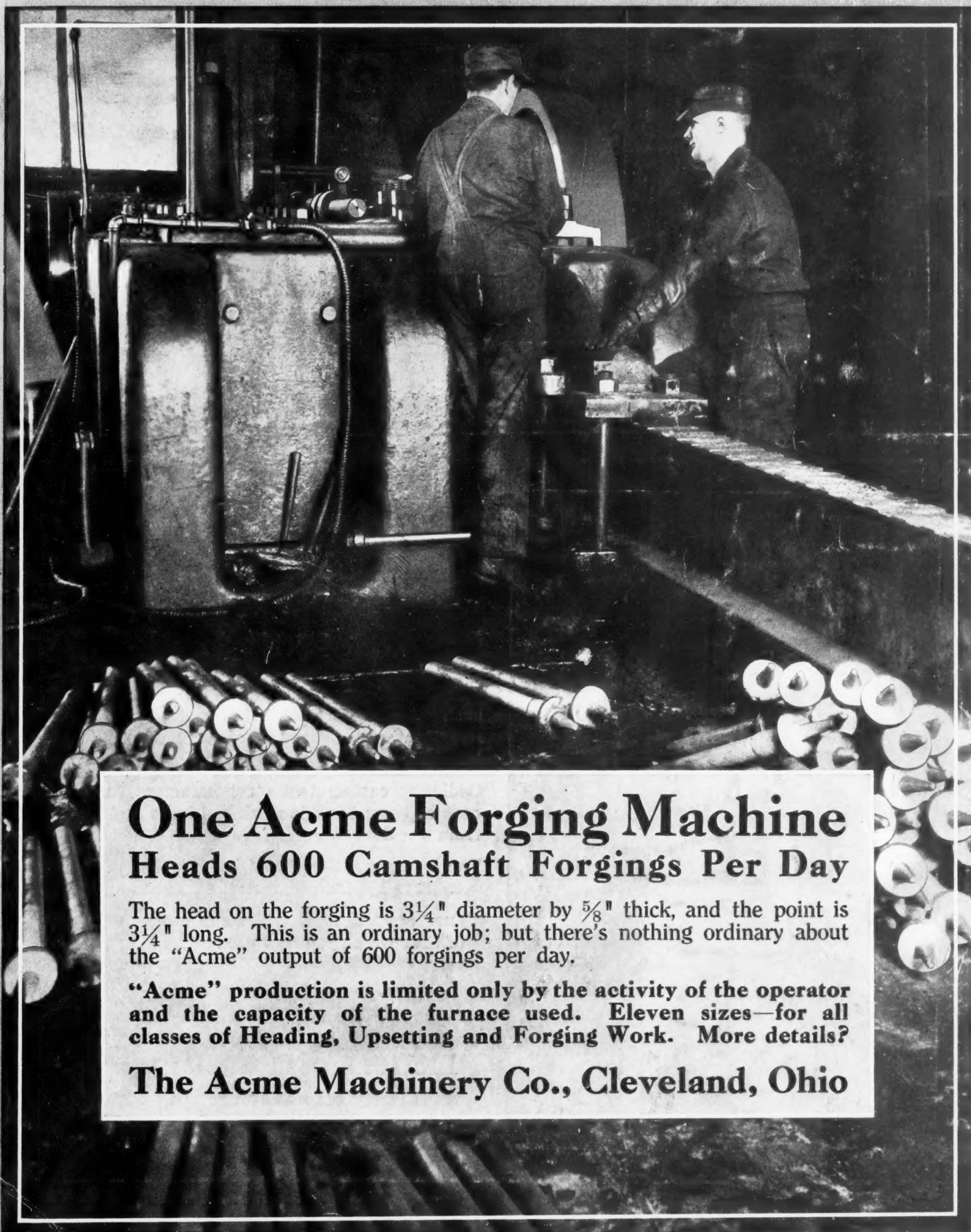
VOLUME 22 NUMBER 8 APRIL, 1916 $2.00 A YEAR 20 CENTS A COPY

THE LARGEST MECHANICAL CIRCULATION IN THE WORLD

MACHINERY

PUBLICATION OFFICES 140-148 LAFAYETTE STREET, CORNER HOWARD, NEW YORK

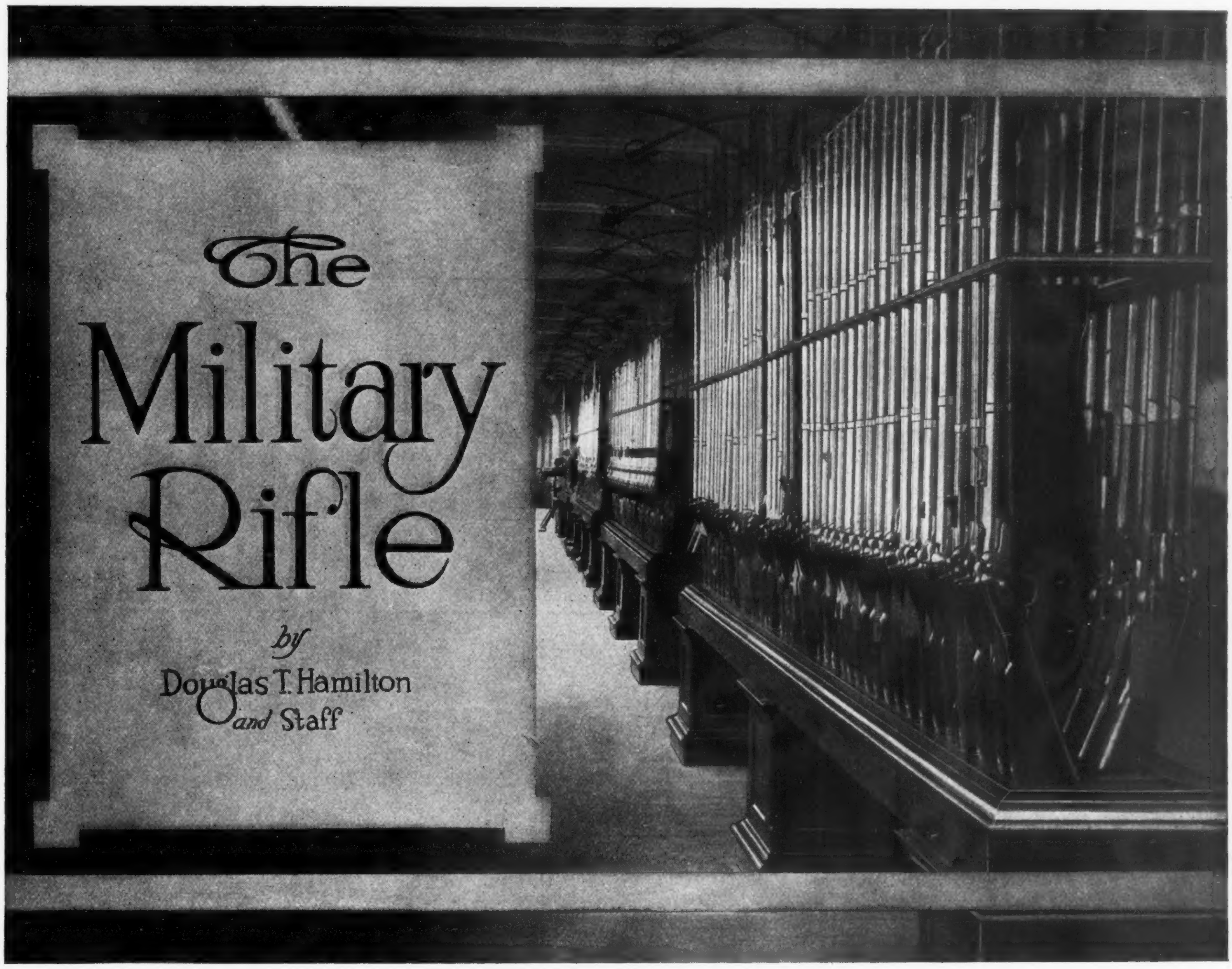


One Acme Forging Machine
Heads 600 Camshaft Forgings Per Day

The head on the forging is 3¼" diameter by ⅝" thick, and the point is 3¼" long. This is an ordinary job; but there's nothing ordinary about the "Acme" output of 600 forgings per day.

"Acme" production is limited only by the activity of the operator and the capacity of the furnace used. Eleven sizes—for all classes of Heading, Upsetting and Forging Work. More details?

The Acme Machinery Co., Cleveland, Ohio



The modern military rifle is the result of five centuries of inventions and developments to which thousands have contributed their best ideas. The manufacture of military rifles requires the highest types of men, machinery, tools and equipment. At present, when millions of rifles are being made in this country for the nations at war, the following articles are of extraordinary interest. The unusual and complicated machining operations are described in detail and illustrated. The organization is outlined and the specifications are tabulated.

THE modern military rifle is an evolution from the musket or shoulder gun, which came into use in Europe in the fifteenth century, displacing the matchlock. The matchlock musket was superseded, in turn, by the wheelock, the snaphance, the flintlock and the percussion gun. The flintlock (see Fig. 1) was the first shoulder firearm to be generally used in warfare. Although the method of firing the charge was crude, it permitted the soldier to aim and fire quickly. The flintlock musket had a smooth bore of comparatively large diameter, and fired spherical bullets. The invention of fulminate of mercury percussion caps for igniting the powder charge in 1799 brought the percussion lock to the front and displaced the clumsy, slow and non-dependable flintlock. All these early guns were muzzle loaders, the powder charge and bullet being inserted into the bore at the muzzle and pushed to the breech by a ram-rod. An improvement in firearms ranking with the percussion cap or primer was the rifled bore which appeared early in the sixteenth century. Little is known of the origin or early development of rifling or helical grooving of the bore to give rotation to the bullet in flight. It has been attributed to several men, one of whom was Gaspard Koller, a gunsmith in Vienna, Austria.

Improvements in Military Rifles

The rifled bore improved the accuracy of fire, but difficulty was experienced in expanding the ball so that it would follow the rifling grooves. Various devices were adopted for expanding the ball, such as ramming it onto a pointed projection at the breech end of the barrel, etc., with more or less success. After the adoption of the rifled bore, attention was directed more to the bullet than to the arm itself. The first bullet was of spherical shape similar to that which had been fired from the smooth-bore musket, but for obvious reasons this was not satisfactory. Bullets were then made with bands, "wings," cup-shaped, etc., the development gradually leading up to the design of a bullet of oblong shape. No marked improvements were made, however, until 1849 when Captain Minié devised a hollow base bullet which was expanded by the explosion of the powder charge. This bullet was designed for use in the Thouvenin rifle, and was oblong in shape, with a hollow base in which a hemispherical iron cup was inserted.

The first rifled muskets had seven grooves in the bore with a twist of about one turn in ten feet. The twist of the rifling grooves was increased with improvement in accuracy, and in the Brunswick rifle, brought out in 1836, the twist was made one turn in thirty inches—the length of the barrel. This proved unsatisfactory, however, as it was found that the bullet was driven across the lands instead of following the grooves. The grooves were then made with an increasing depth to assist the bullet in following them, but this made a difficult rifling proposition. An increase in the depth of the grooves also proved unsatisfactory.

For information on rifle manufacture previously published in MACHINERY, see "Manufacture of Savage 0.22 Caliber High-power Rifle" in the July and August, 1914, numbers of MACHINERY and articles there referred to.

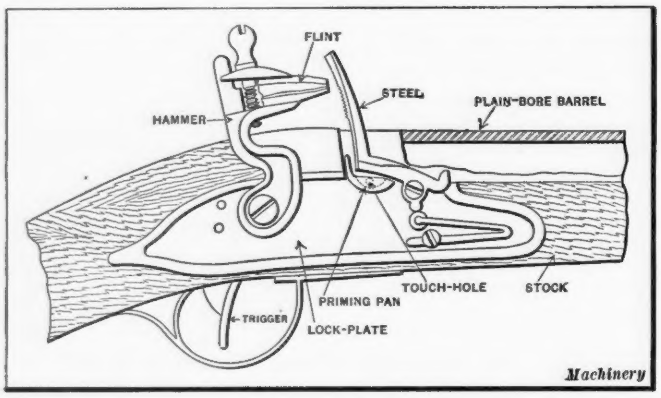


Fig. 1. First Successful Military Shoulder Gun employing a Flintlock

In 1854 Mr. Whitworth brought out a rifle with a hexagonal bore having a twist of one turn in twenty inches and measuring 0.450 inch across the flats. The bullet was also made of hexagonal shape. Other rifles having bores of polygonal shape were tried but discarded. Owing to the difficulty of producing hexagonal and polygonal bores, rifling was again resorted to, and in 1865 Mr. Metford produced a rifle of 0.450 caliber, having five shallow grooves and firing a lead bullet hardened with antimony and wrapped in a thin paper patch. Expansion of the bullet, which was made cup-shaped, was effected by the force of the powder explosion on its base.

Development of Breech-loading Rifles

The disadvantages of the muzzle-loading rifle were early appreciated, and many attempts were made to load at the breech.

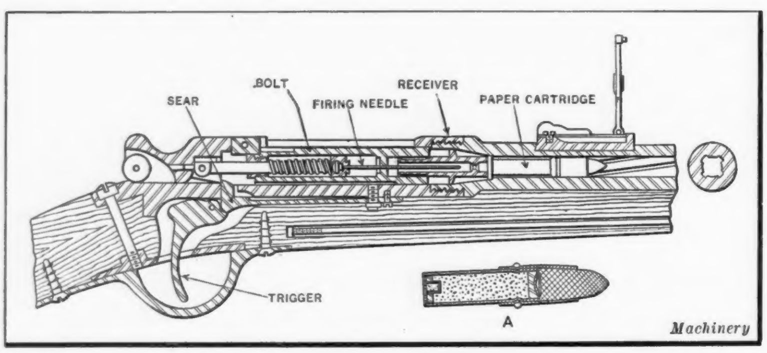


Fig. 2. French Chassepot Rifle of 1866

Even as early as the sixteenth century rifles were designed to load at the breech. One of the first attempts consisted in having a side entrance to the bore at the breech through which the bullet and powder were inserted, the cavity being closed by a screw. The first practical breech-loading rifle was the Prussian needle gun invented by Dreyse in 1838 and adopted by Prussia in 1841. In this rifle the breech was closed by a mechanism resembling the turn-bolt of a door. Ignition was effected by a long needle carried in the bolt, which was driven forward by a spiral spring upon pulling the trigger. The needle, when forced forward, pierced the base of the cartridge and ignited the powder charge by striking a disk of fulminate of mercury contained within it. The escape of gas from the breech proved troublesome, but the gain in rapidity of loading more than compensated for this defect. This rifle, while unsatisfactory in many respects, was an improvement over previous designs and was used by Prussia with marked success in the wars of 1848, 1866 and 1870.

Types of Breech Mechanism

The advantages of the breech-loading rifle were soon recognized by all the leading powers, and many were designed in the first half of the nineteenth century. The majority of breech mechanisms were provided with some sort of a hinged block which was turned over to give access to the chamber in which the charge was placed. The type known as the "Lefaucheux System" had the barrel hinged at the breech end somewhat similar to the present-day shot gun. While this system proved satisfactory for shot guns, it was never considered of practical value for military rifles. Another breech mechanism known as the revolving type, consisted in rotating the barrel eccentrically in relation to the breech end, but this was soon discarded owing to the difficulty of preserving the correct alignment between the two members, and the leakage of gas between the chamber and the barrel.

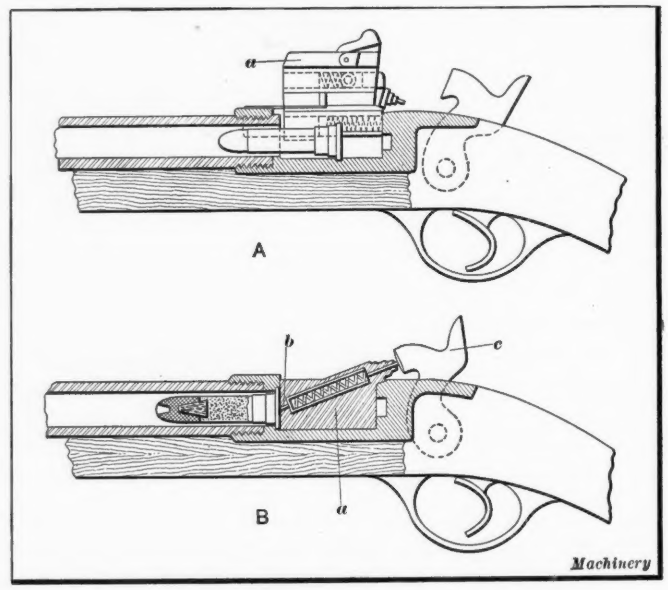


Fig. 3. Breech Mechanism designed by Jacob Snider in 1866

In most of the breech-loading guns invented between 1850 and 1860, the percussion cap was separated from the charge, being located on a nipple. The flame from this cap had to pierce the cartridge and ignite the charge. This system was adopted in the early Sharp, Terry, Greener and Westley-Richards rifles. The Sharp, which was an American rifle, was patented in 1852. The breech end of the barrel was closed by a slide, actuated by a lever forming the trigger guard. To load the rifle, the slide was drawn down to insert the cartridge, and when raised it closed the breech, and at the same time the sharpened top edge cut off the end of the cartridge exposing the powder to the flame of the percussion cap.

In the Terry rifle a tallowed wad was fixed at the

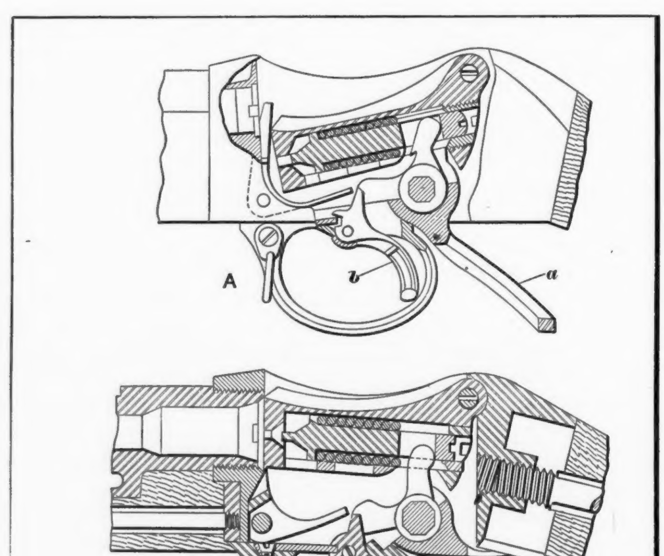


Fig. 4. Martini Bolt Action designed in 1870

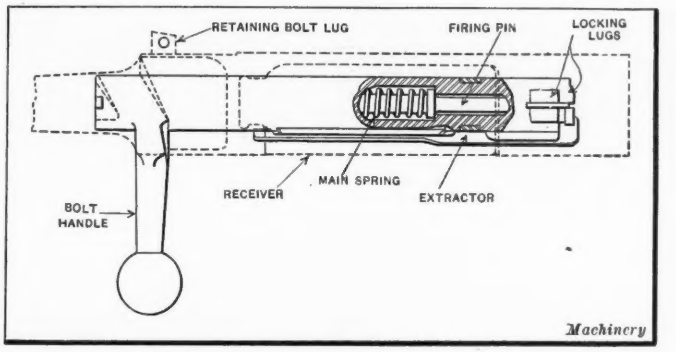


Fig. 5. Diagram illustrating Construction of Mauser Type of Bolt Action

base of the cartridge, and the charge was ignited from the center. The ball was made larger than the bore so that it filled the grooving when forced into the rifling. The Westley-Richards rifle had a hinged block that opened forward, and like the Terry, used a felt wad that served as a gas check. In the Greener carbine, the barrel was unlocked from the breech and slid forward. The escape of gas was prevented by a sliding tube having a tapered ring at its rear end, which acted in the same manner as the obturator used on large caliber guns.

This principle was also taken advantage of in the French Chassepot rifle, designed in 1866 (see Fig. 2), which had a straight-pull bolt, and was arranged to carry a combustible cartridge *A*. This was made with a paper case, and it had a cap in the center of the base; the face of the bolt was provided with a rubber washer to check the escape of gas. About the same time Colonel Boxer devised a cartridge with a case

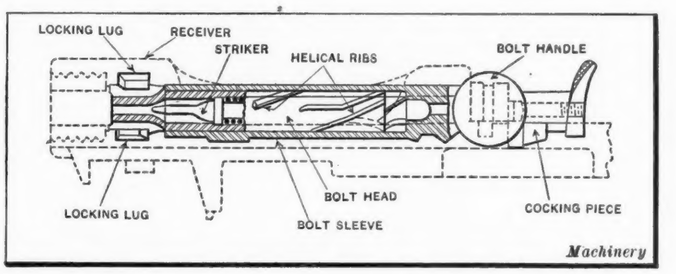


Fig. 6. Diagram illustrating Principle of Construction of Mannlicher Bolt Action

made from coiled brass instead of paper. This was first used in the Snider rifle. The invention of the coiled brass cartridge case gave great impetus to the development of breech-loading rifles. The Boxer case was made from sections of coiled brass; the head, which carried the percussion cap or primer, was attached by solder. Previous to the invention of the brass case, all cartridge cases were made from paper, and consequently were not gas tight. The breech mechanism had to be made so as to prevent the escape of the gases, which was practically impossible. The built-up cartridge case designed by Colonel Boxer was much superior to the paper cartridge case, but it was bulky and not altogether a perfect gas check because of defects in construction. The principle, however, was sound and the later development of the one-piece drawn cartridge case overcame the objections inherent in the Boxer cartridge.

The Snider Breech Mechanism

One of the early breech mechanisms used with considerable success was that designed by Jacob Snider and adopted by the British government in 1867. In this rifle a swinging block was held in a recess in a short receiver screwed to the breech end of the barrel. The block *a*, as shown in Fig. 3, was hinged on the right-hand side of the receiver, which on being opened gave access to a tapered chamber in the breech end of the gun. A projecting spring pin held the block in place when opened. Located on the front end of the block was a hook extractor that engaged the head of the cartridge case to withdraw it after being discharged. In lifting up the block, it also could be withdrawn a short distance; this extracted the cartridge from the chamber, and it could then be thrown out by turning the rifle over. The striker *b* was located diagonally in the block and when struck by hammer *c* was caused to hit the cap in the head of the cartridge. The bullet had a hollow in its base in which a taper plug of wood or clay was inserted to cause it to expand into the rifling grooves. The front end was also made hollow so as to distribute the weight evenly and thus increase the accuracy.

The Martini Breech Mechanism

The Snider breech block had several disadvantages, chief among which was the difficulty experienced in preventing the escape of gas. A considerable improvement in breech mechanism was devised by Mr. Martini in 1870 and finally adopted in 1871. As shown in Fig. 4, this action was designed along the lines of some of the present-day sporting rifles. Instead of the block being hinged to lift up, it was dropped down by operating lever *a*. This gave access to the chamber in the

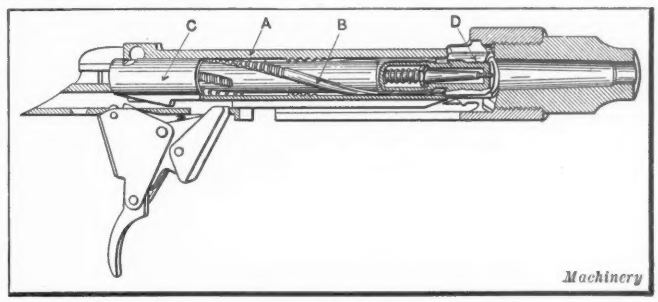


Fig. 7. Ross Straight-pull Bolt Action designed in 1907

barrel and when the block was raised the breech was effectively closed. The firing pin was carried in this block and was released by pulling trigger *b*. This breech mechanism was applied to the Henry barrel, and the combination was known as the Martini-Henry rifle. The barrel was 33.2 inches long, 0.450 inch caliber, and had seven shallow grooves making one turn to the right in 22 inches. The muzzle velocity was 1350 feet per second.

Modern Rifle Bolt Actions

The bolt actions used in modern military rifles may be divided into two groups: (1) those in which the bolt is rotated by raising the bolt lever before the bolt can be withdrawn; (2) those that can be drawn straight back to the rear without any rotary movement of the hand-lever, known as "straight-pull" bolts.

Those in the first group are used by all the principal coun-

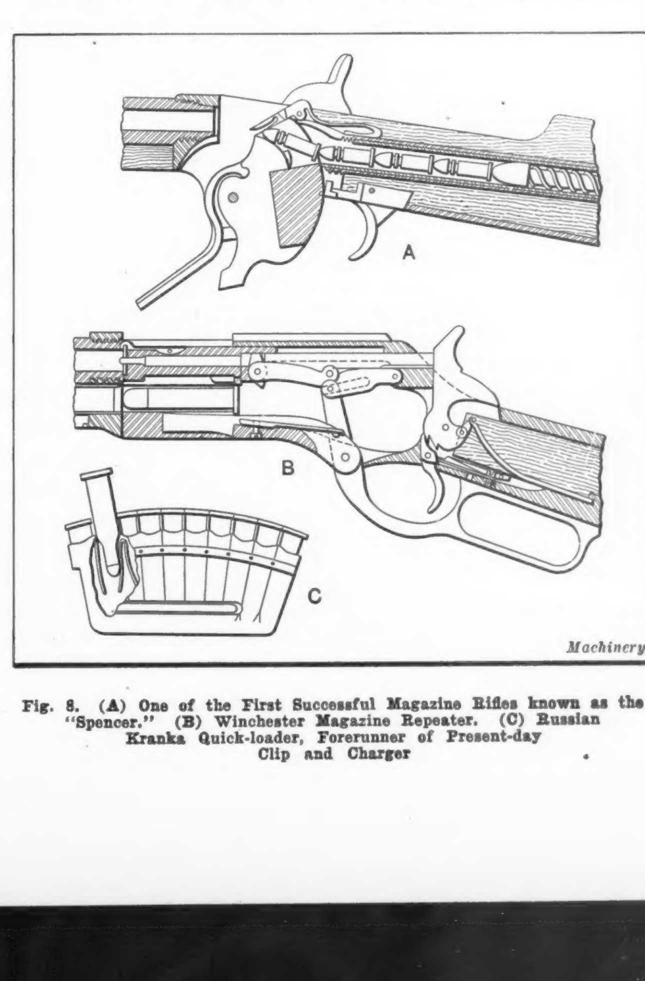


Fig. 8. (A) One of the First Successful Magazine Rifles known as the "Spencer." (B) Winchester Magazine Repeater. (C) Russian Kranka Quick-loader, Forerunner of Present-day Clip and Charger

Fig. 9. French Lebel Military Rifle, Model 1886

tries with the exception of Austria, Switzerland and Canada. These three employ the "straight-pull" bolt action. One of the advantages of a rotating bolt is that a powerful loosening action can be exerted on the fired cartridge case by the bolt handle working on the receiver cam surface. If the bolt is supported by symmetrical lugs as in the Swiss rifle and Austrian pattern of 1895, the lugs have to be rotated to clear them from their seating in the receiver. In the rotating bolt action this is avoided by rotating the bolt by the bolt lever. vibration and affecting the accuracy of fire. When the lugs are on the front end of the bolt, the symmetrical front of the receiver and bolt resist the backward motion of the cartridge on firing, but the recess in which the lugs work is difficult to clean out if sand gets into it, which may happen in hot countries where dust storms occur. The French and Russian rifles have bolt heads which carry the locking lugs and rotate with the bolt. This system appears to have no advantage except for repair purposes. The most desirable bolt is one in which the fore end is solid and is locked in cam shaped grooves in the front end of the receiver, as in the Mauser rifle.

TABLE I. THE PRINCIPAL DIMENSIONS AND SPECIFICATIONS OF MILITARY RIFLES USED BY THE VARIOUS GOVERNMENTS

Country	Model (year)	Designation	Magazine System*	No. of Cartridges in Magazine	Weight in Pounds (without bayonet)	Total Weight, Pounds	Length (without bayonet), Inches	Total Length, Inches	Length of Barrel, Inches	Caliber of Bore, Inches	No. of Rifling Grooves	Depth of Grooves, Inches	Shape of Grooves	Twist of Rifling, Inches	Muzzle Velocity,† Feet per Sec.
Austria and Bulgaria	1895	Mannlicher	Fixed Vert. Box	5	8.34	8.98	50.00	59.50	30.12	0.315	4	0.0080	Concen. Beveled Edge	9.842	2840 2034
Belgium	1898	Mauser	Detach. Vert. Box	5	8.03	9.56	50.25	59.75	30.67	0.301	4	0.0065	Concen.	9.842	1975
Canada	1907	Ross	Fixed Vert. Box	5	8.06	9.08	52.00	58.80	28.00	0.300	4	0.0055	Concen.	10.000	2800
Denmark	1889	Krag-Jorgensen	Fixed Horiz. Box	5	9.73	10.28	52.75	63.00	32.90	0.315	6	0.0075	Metford Segmental	11.811	2535
France	1907-15	Lebel	Fixed Vert. Box	3	6.91	7.83	51.12	71.84	31.49	0.315	4	0.0059	Concen.	9.450	2310
Germany	1898	Mauser	Fixed Vert. Box	5	9.00	9.87	49.40	69.75	29.05	0.311	4	0.0065	Concen.	9.390	2960
Great Britain	1907	Lee-Enfield Mark I	Detach. Vert. Box	10	9.25	8.64	49.50	61.50	30.19	0.303	5	0.0065	Concen.	10.000	2060
Great Britain	1907	Lee-Enfield Mark III	Detach. Vertical Box	10	10.22	9.64	44.50	61.50	25.19	0.303	5	0.0058	Concen.	10.000	2440
Greece	1903	Mannlicher-Schoenauer	Fixed Vert. Box Rotary Platform	5	8.34	9.00	48.37	58.12	28.56	0.256	4	0.0065	Concen. Round Edge	....	2400
Holland	1895	Mannlicher	Fixed Vert. Box	5	9.68	10.42	51.00	60.75	31.12	0.256	4	0.0065	Concen. Round Edge	7.874	2433
Italy	1891	Mannlicher-Carcano	Fixed Vert. Box	6	8.40	9.18	50.75	62.37	30.75	0.256	4	0.0060	Concen.	Increasing from 19¼ to 8¼	2300
Japan	1907	Year 38 Pattern	Fixed Vert. Box	5	8.63	9.56	50.75	65.75	31.30	0.256	4	0.0060	Metford Segmental	7.875	2420
Portugal	1904	Mauser-Verguiero	Vert. Box Mov'bl Box	5	8.81	9.59	48.00	59.25	29.08	0.256	4	0.00575	Concen. Round Edge	7.780	2347
Roumania	1893	Mannlicher	Fixed Vert. Box	5	8.80	9.59	48.50	58.25	28.56	0.256	4	0.0065	Concen. Round Edge	7.874	2430
Russia	1894	Mauser-"3 Line" Nagant	Fixed Vert. Box	5	8.95	9.70	51.87	69.00	31.50	0.300	4	0.0070	Concen. Round Edge	9.500	2886
Spain	1896	Mauser	Fixed Vert. Box	5	9.42	10.34	48.62	58.50	29.03	0.276	4	0.0055	Concen. Round Edge	8.680	2330
Switzerland	1900	Schmidt-Rubin Short Rifle	Detach. Vert. Box	6	8.03	8.64	43.12	58.75	23.33	0.295	3	0.0039	Concen. Round Edge	10.630	2705
Turkey	1893	Mauser	Detach. Vert. Box	5	9.06	10.50	48.60	66.60	29.13	0.301	4	0.0055	Concen. Round Edge	10.000	2140
United States	1903	Springfield	Fixed Vert. Box	5	8.69	9.69	43.21	59.21	24.006	0.300	4	0.0040	Concen.	10.000	2750

Machinery

* In connection with the magazine systems of the various rifles, a charger instead of a clip is used, with the exception of those used by Austria, Bulgaria, Holland, Italy and Roumania; the Canadian rifle uses neither a charger nor clip. Of the rifles listed, only those used by Canada, Denmark, Germany, Great Britain, France, Turkey and United States have cut-offs in the magazine.

† Due to the adoption of improved smokeless powder since the time these data were compiled, some of the muzzle velocities have been increased from 10 to 25 per cent above those given in the table.

There are many forms of rotating bolts. For instance, in some cases the bolt head does not rotate, and the bolt itself is locked at the rear instead of at the front end. In others, there is no separate head and the locking lugs are on the front end of the bolt, no lugs being provided at the rear. Then there are bolts with both a rotating bolt head and locking lugs. One of the rotating bolts, the Lee-Enfield, is the only one with the lugs near the rear part of the bolt. The disadvantage of this arrangement is that upon firing, unsymmetrical stresses are set up in the bolt and receiver, causing lateral

The Mauser Bolt Action

The Mauser bolt, which is shown diagrammatically in Fig. 5, is of strong and simple construction without a movable bolt head. It can be stripped without the use of tools and is locked by lugs on the front end engaging with cam-shaped grooves cut in the receiver. This form of bolt, which is of the "turn" type, is used with slight modifications on the greater number

Fig. 10. German Mauser Military Rifle, Model 1898

Fig. 11. Spanish Mauser Military Rifle, Model 1896

of military rifles. The Belgian, German, Spanish and Turkish Mauser breech mechanisms vary to a slight extent in the construction of the bolt. Of these four, the Spanish bolt is the simplest, but it has been found to be rather weak as compared with the German bolt. On the German bolt an extra lug engaging in a recess in the cylindrical part of the receiver gives additional support when the cartridge is fired.

The face of the bolt is recessed to receive the head of the rimless cartridge. The lever on the bolt is straight and extends at right angles from the rear end. The left-hand lug has a slot cut in it in which the ejector slides when the bolt is withdrawn to eject the cartridge. The extractor fits on the outside of the bolt and is held in place by a spring collar working freely in a groove cut in the body. On the Spanish Mauser this extractor is exposed and unsupported, except for the retaining ring, whereas on the German Mauser a rib is provided which supports the extractor, giving it greater strength at the time of primary extraction. The operation of this bolt will be more fully described in connection with the description of the Mauser rifle.

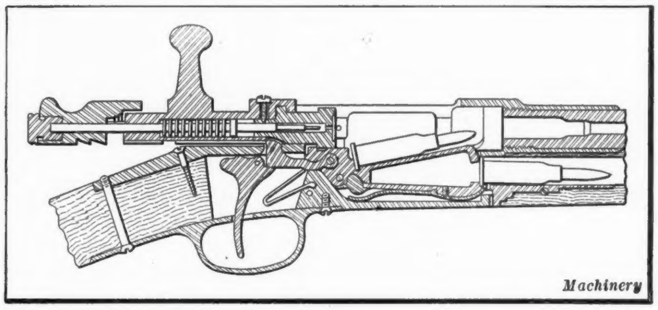


Fig. 12. Diagram showing Breech Action of French Lebel Rifle

The Mannlicher Bolt Action

As has been previously mentioned, the Mannlicher bolt action is of the "straight-pull" type. This is diagrammatically shown in Fig. 6. The bolt proper is a hollow cylinder with ribs on each side which work in straight grooves in the receiver. Inside the middle portion of the bolt are two helical feathers or ribs which work in corresponding grooves in the tail of the bolt head and give it a rotary movement in opening and closing the bolt. A groove is cut on the inside of the right rib of the bolt sleeve or cylinder for the extractor.

The bolt consists of the head proper which projects beyond the face of the bolt cylinder, and the tail which enters the cylinder. The bolt head has locking lugs on each side which enter the recesses in the receiver by way of the cam-shaped grooves, and support the bolt head in the firing position. A groove is cut in the head for the ejector. The rear end of the tail has two external helical grooves in which the feather on the cylinder works. The helical grooves have a small groove leading out of them parallel to the axis of the bolt, one to the front and the other to the rear. The one to the front is on top of the tail and that to the rear on the right-hand side when the bolt is open.

This bolt is operated by a pull and push action. When the lever is pulled to the rear, the bolt cylinder cannot revolve because the ribs on it work in the grooves of the receiver and the feathers in the under-cut grooves in the tail. The bolt head, on the other hand, cannot move to the rear until the locking lugs have been disengaged from the recess in the receiver, and this is effected by the turning motion given to the tail of the bolt head by the helical feathers in the inside of the bolt cylinder working in the bolt head tail. Primary extraction is effected by the cam-shaped ends of the grooves in the receiver in which the bolt locking lugs work. The first motion of the bolt to the rear partly compresses the main spring, and as soon as the locking lugs are disengaged from the receiver "cams" they are in line with the ribs on the bolt cylinder and the entire bolt can then be drawn to the rear until arrested by the feathers on the under side of the bolt coming in contact with the horns of the trigger. In closing the bolt, the above movements are reversed, the sear tooth engaging the stud of the cocking-piece and completing the compression of the main spring. The action can be cocked without opening and closing the bolt by pulling back the cocking-piece. At full cock the locking bolt can be used as a safety bolt.

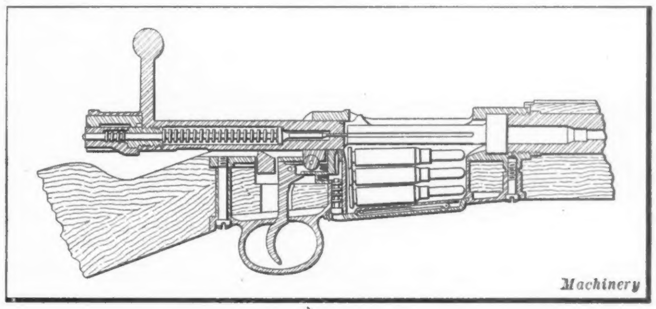


Fig. 13. Diagram showing Breech Action of Spanish Mauser

The Ross "Straight-pull" Bolt Action

The Ross "straight-pull" bolt action used in the Canadian military rifle was designed by Sir Charles Ross in 1907. It is a modification of the Mauser bolt coupled with the "straight-pull" feature of the Mannlicher type, and is shown in Fig. 7. It comprises a bolt sleeve *A* which acts as a carrier for the bolt *B* and is provided with a handle at the rear. On the exterior bolt surface are two ribs which slide in corresponding grooves in the sides of the receiver. The left rib has a lug engaging with the bolt stop. The extractor is held in an under-cut groove in the top. A slot is cut in the rear end to guide the cocking-piece. The interior is provided with spiral ribs similar to those on the body of the bolt which give the turning movement necessary to lock the bolt. The bolt and the bolt head are made in one piece and are machined to receive the striker and main spring. The lugs *D* on the front end engage shoulders in the receiver and support the bolt while the cartridge is being fired. The front face of these lugs is cam-shaped to facilitate extraction of the cartridge.

Fig. 14. Austrian Mannlicher Military Rifle, Model 1895

With this bolt mechanism a straight pull back releases the lugs from the shoulder in the receiver, and extracts the cartridge; and a straight push forward inserts the cartridge and cocks the arm ready for firing.

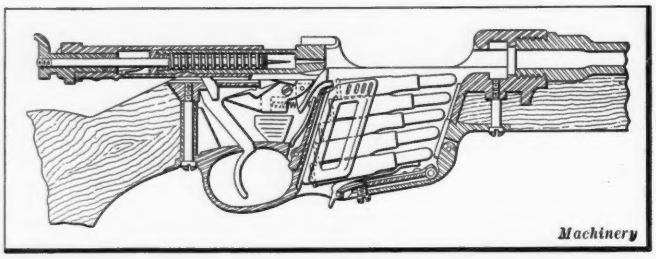


Fig. 15. Diagram showing Breech Mechanism of Austrian Mannlicher Rifle

Development of Magazine Rifles

The first military rifles which were loaded from the breech end were of the single-shot type. The advantages to be gained by increasing the rapidity with which the rifles could be discharged were recognized early in the history of small arms. A great advance in this direction was made by the adoption of breech-loading rifles, when the powder charge, bullet and igniting agent were contained in one case. Weapons known as repeaters were the first really successful rifles that contained a reserve of cartridges. In this class of weapon the cartridges lay nose to base in a tube contained in the butt or in the fore end of the stock. The breech was opened, the empty case extracted and a fresh cartridge introduced in the chamber. The breech was then closed and the weapon cocked ready for firing. The earliest successful weapon of this class was the Spencer rifle shown at *A* in Fig. 8, which was patented in 1860. This rifle, as the illustration shows, carried the reserve cartridges in a tube in the butt end of the stock, which were followed up by means of a spring controlled plunger.

Fig. 16. Italian Mannlicher-Carcano Military Rifle, Model 1891

The Winchester repeater, shown at *B* in Fig. 8, carried nine cartridges in the magazine, one in the carrier, and one in the chamber. This rifle belonged to that system in which a fixed chamber was closed by a bolt sliding in line with the axis of the barrel and operated by a lever from below. The receiver was divided by a vertical partition into two parts, the carrier occupying the front portion, while the rear contained, with the exception of the breech block lever, the mechanism necessary to operate the breech block and carrier. The breech block was a single piece, the upper end of which had an extractor of the spring hook pattern pinned to it, and at its rear end it supported two side links that formed a knuckle joint.

Fig. 17. British Lee-Enfield Military Rifle, Model 1907, Mark I

The hammer was cocked by the end of the firing pin when the breech bolt lever was thrown forward. The rifle was fired by a center lock of the usual pattern. A safety device prevented pulling the trigger when the rifle was cocked. The shells were ejected by the carrier, which lifted up as they were withdrawn, striking them at a distance of about one-third their length from the rear, rotating them about the extractor and throwing them clear of the rifle. The magazine was in the fore end of the stock, and was loaded through a gate in the side cover of the receiver.

The Kranka Quick-loader

The Winchester repeater just described was used by Turkey in the Russo-Turkish war of 1877-1878 with such striking effect that the Russian government was called upon to adopt a similar method of handling the single-shot gun at that time used by the Russian troops. The defects of the single-loader were partially overcome by the adoption of a quick-loading device known as the "Kranka quick-loader." It consisted, as shown at *C* in Fig. 8, of a receptacle attached to the side of the rifle, in which there were ten pockets. The cartridges were placed in each pocket in a line, head uppermost, so that they could be quickly withdrawn and forced into the receiver of the rifle in front of the bolt. The rifle was then ready for firing, upon closing the breech mechanism. This quick-loader was the forerunner of the present-day chargers and clips used in connection with a large number of military rifles.

Modern Military Rifles

Following the successful use of the Spencer rifle in 1860, practically all the military powers devoted their attention to the adoption of magazine rifles. The first great power to provide its army with a magazine rifle was the German government. In 1884, it converted the 1871 pattern of the Mauser rifle of 0.433 inch caliber into a magazine rifle, holding eight cartridges in a tube magazine located in the fore end of the stock. All the magazine rifles up to this time were over 0.44 inch caliber, and the French government was the first to reduce the bore below this, when it brought out the Lebel rifle in 1886. This had a bore of 0.315 inch—which is the caliber of the present rifle—and contained eight cartridges located in a tubular magazine in the fore end of the stock. At the beginning of the present war, however, this tubular magazine was dispensed with and a breech magazine holding three cartridges was adopted in its place.

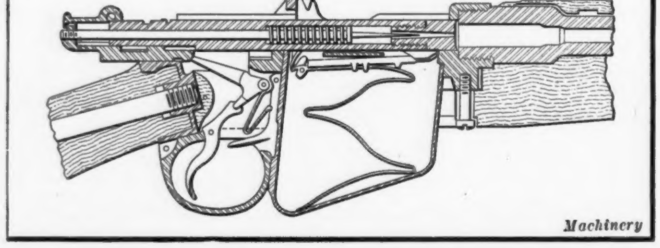


Fig. 18. Diagram showing Breech Action of British Lee-Enfield Rifle

In 1886, the Austrian government adopted the Mannlicher rifle of 0.433 inch bore with a "straight-pull" bolt and at the same time adopted Lee's box magazine, which was patented in 1879 and consisted of a box below the entrance to the chamber, containing the cartridges placed horizontally one above the

other. A platform actuated by a spring pushed the cartridges upward, so that when the bolt was pushed forward it struck the head of the top cartridge and pushed it into the chamber of the barrel. Another important improvement introduced with this rifle was the principle of multiple loading, which was effected by a sheet steel clip containing five cartridges. The clip full of cartridges was pressed into the magazine and retained by a catch until the cartridges were expended, when it fell out through an opening in the bottom of the magazine. In 1888, the bore of the Mannlicher rifle was changed from 0.433 to 0.315 inch, which is also the caliber of the latest or 1895 model. The development in military rifles has been toward a gradual reduction of the bore, the smallest at the present time being 0.256 inch. This caliber has been adopted by Greece, Holland, Italy, Japan, Portugal and Roumania as shown in Table I.

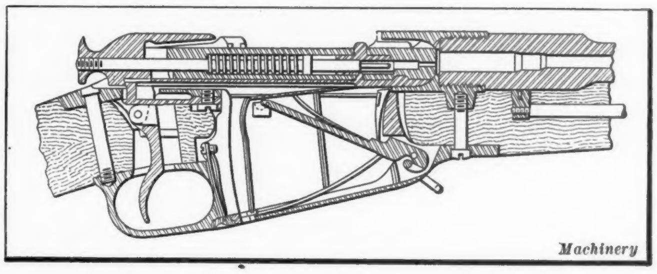


Fig. 19. Diagram showing Breech Action of Russian Three-line Nagant Military Rifle

Fig. 20. Russian Three-line Nagant Military Rifle, Model 1894

The French Lebel Military Rifle

The Lebel rifle, shown in Figs. 9 and 12, was the first small-bore rifle to be adopted by any nation, and with it smokeless powder was first used. It is of the turn-bolt type, the bolt being a cylinder bored out from the front end for the main spring, and with a straight lever terminating in a knob near the rear end. It differs from other military rifles in that the stock is made in two pieces, the butt and fore end being joined to the receiver that extends clear down to the bottom of the

Fig. 21. Japan 38th Year Pattern Military Rifle

stock. Some slight modifications have lately been made in this rifle to convert it from a tube magazine rifle to one using a charger that holds three cartridges.

The action of the breech mechanism of this rifle is briefly as follows: Upon turning up the bolt lever, the tooth on the cocking-piece rides up on the inclined face of the cam recess on the bolt and the point of the tooth drops into the recess. This compresses the main spring partially. The cocking-piece is prevented from turning with the bolt by the projection being supported by the sides of the receiver. As the bolt is being opened, the lugs on the bolt head are turned in front of their support into a vertical position and the front end of the projection on the bolt is forced back by the curved face of the receiver. The bolt lever and rib are now in line with the openings in the sides of the receiver, so that the bolt and empty cartridge held by the extractor can be drawn back. When the bolt is fully withdrawn it is stopped by the lower lug striking the end of the partition in the receiver. At the same time, the end of the ejector screw strikes behind the left ledge of the cartridge head and ejects the empty cartridge to the right.

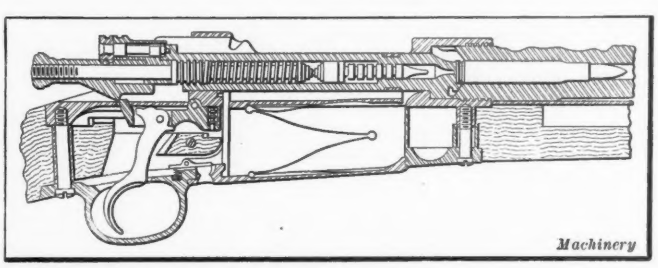


Fig. 22. Diagram showing Breech Action of Springfield Rifle, Model 1903

Upon pressing the bolt forward, the face of the bottom lug strikes the base of the cartridge in the carrier which has just been raised and pushes it forward into the chamber. As the front of the rib meets the curve on the receiver, the sear engages the cocking-piece and when the bolt lever is turned down, the lugs on the bolt head pass along the curved entrances to the recesses and force the bolt in, completing the compression of the main spring.

The German Mauser Rifle

The German Mauser rifle, shown in Fig. 10, is the model of 1898 and is of the turn-bolt action, after which practically all the modern military rifles have been patterned. This rifle has a bore of 0.311 inch and a muzzle velocity of approximately 2900 feet per second. It fires a nickel-coated steel-cased bullet, weighing approximately 154½ grains. It is supplied with a fixed vertical box magazine and is loaded with a charger containing five cartridges. The bolt is locked in the receiver by lugs on the fore end and is additionally supported by a lug at the rear end. ~~The extractor differs from the one used on the Spanish Mauser in that a lug~~ supports it during primary ~~extraction. The extractor is held to the bolt by means of a split collar~~. The construction and operation of the bolt has been previously described.

The Spanish Mauser

The Spanish Mauser, shown in Figs. 11 and 13, differs very little from the German Mauser. The only modifications aside from the sights and other less important details, are in the bolt and bolt plug. The bolt is made extremely plain, having only two locking lugs on the fore end that fit in corresponding cam grooves in the receiver, and is plain on the rear except for a flat, cocking cam slot, safety bolt lock slot, and a locking slot, for the cocking-piece. The extractor is held by a collar the same as in the German Mauser, but is not supported by a lug during primary extraction. The other important details of this rifle are given in Table I.

Austrian Mannlicher Rifle

The Austrian Mannlicher rifle, shown in Figs. 14 and 15, is of the "straight-pull" bolt type, as has previously been described. The magazine carries five cartridges which are

held in a clip. As soon as all the cartridges have been removed, the clip drops out of the magazine through an opening in the bottom. The bore of the rifle is 0.315 inch, and it fires a lubricated steel-cased bullet weighing about 244 grains. The "straight-pull" bolt action can be operated slightly faster than the turn-bolt type, but has not the same strength as the latter.

The Italian Mannlicher Carcano Rifle

In this rifle, the Mannlicher type of clip holding six instead of five cartridges is used. The breech mechanism is that introduced by M. Carcano of the Turin Small Arms factory, and is a modified Mauser action. As shown in Fig. 16, the Italian rifle bears a marked resemblance to the Austrian as far as exterior appearance is concerned. The bolt, which is not provided with a separate bolt head, has a lug on each side at the front end. The extractor passes through a slot in the right lug into its seating in the rear. The front end of the bolt is recessed to fit the head of the cartridge, and the rim or recess is cut away at the bottom to allow the cartridges to move up the face of the bolt so that the extractor may enter into the groove, thus avoiding any chance of double loading. The rifling is of the progressive twist type, beginning at the breech end with one turn in 22.9 inches and ending with one turn in 7.5 inches at the muzzle.

The British Lee-Enfield Rifle

In the British Lee-Enfield rifle, shown in Figs. 17 and 18, the bolt is designed on the Mauser principle and the bolt head does not rotate with the bolt proper. The Lee-Enfield is the only one of the rotating bolts which has the locking lug near the rear. The disadvantage of this arrangement in firing is that unequal strains are introduced in the receiver and bolt, which cause lateral vibration and necessitate placing the foresight to one side of the barrel as previously explained. The caliber of this rifle is 0.303, and it fires a nickel-jacketed pointed bullet weighing approximately 150 grains, with a muzzle velocity of 2200 feet per second. Another variation in the British Lee-Enfield is that the magazine, instead of holding five or six cartridges, holds ten and is fed by a charger instead of a clip. A magazine cut-off is provided.

The Russian Three-line Nagant Rifle

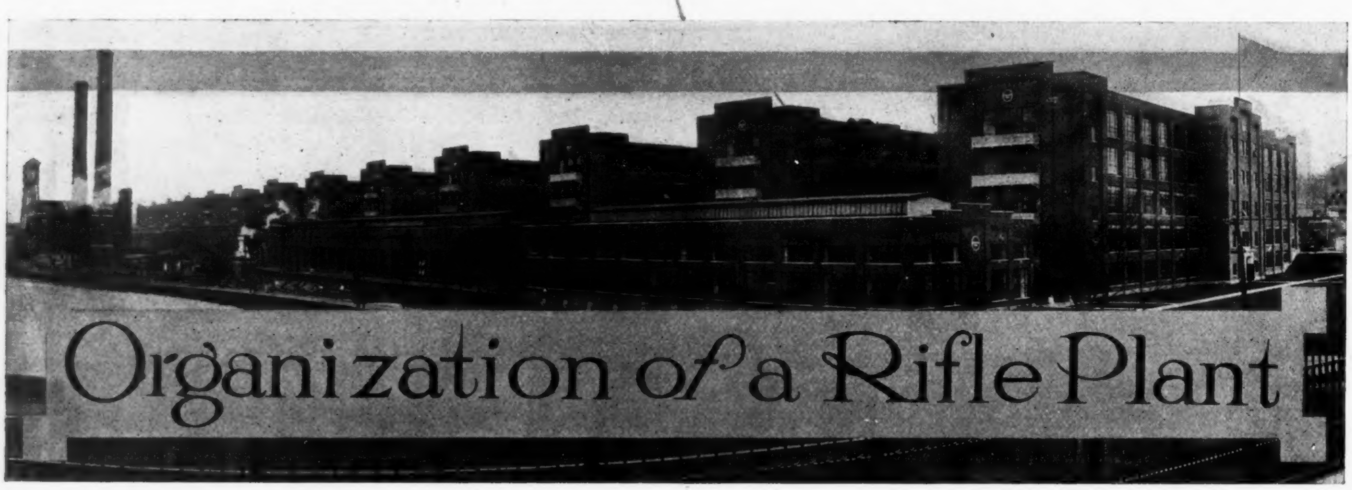
The Russian three-line Nagant rifle, shown in Figs. 19 and 20, is of the turn-bolt type, having a magazine that works on the charger principle. The bolt is provided with a separate head which turns with the bolt and, together with a connecting bar, acts as a guide to the cocking-piece and helps to retain the bolt in the body. To charge the magazine, the charger is placed into the recess cut for it in the bridge of the receiver and the cartridges are forced out by a pressure of the thumb. The charger when empty must be removed by hand. There is no cut-off and the rifle can only be used as a single loader when the magazine is empty. It carries five cartridges.

Japan Year 38th Pattern Rifle

This rifle, which was introduced in 1907 and is shown in Fig. 21, is patterned after the Mauser rifle. The locking lugs of the bolt are on the front end and the extractor is attached to the bolt in the same manner as in the Mauser. The bolt, however, instead of being exposed is covered by a sheet-steel bolt cover, somewhat similar to that used on the Lee-Enfield rifle. The magazine, which holds five cartridges in two columns, is made of sheet steel, the bottom part fitting into an opening made in the front end of the receiver. The bottom of the magazine is closed by a hooked plate. When the magazine is empty, the rear end of the platform prevents the bolt from being closed and thus indicates that the magazine requires refilling. A charger is used instead of a clip.

The American Springfield Rifle

The American Springfield rifle, shown in Figs. 22 and 23, was brought out in 1903 to displace the Krag-Jorgensen formerly employed. This rifle is almost identical with the German Mauser. Of course it has a few modifications, but these are of comparatively minor importance. The extractor is held to the bolt by means of a collar, the same as in the regular Mauser, but in addition it is backed up by a lug, thus reducing the strain on the collar when forcing the extractor over the head of the cartridge. The bolt handle is bent down, as on the Lee-Enfield. The bullet, of the Spitzer type, is 0.303 caliber and has a muzzle velocity of 2750 feet per second.



THE organization of a plant to turn out a modern military rifle does not differ in essentials from that of any other plant that makes interchangeable parts. The methods of laying out the work, planning the order of operations, and routing the work through the plant, etc., can also be applied to the manufacture of a typewriter, automobile, machine tool, or in fact any other interchangeable product. It is therefore evident that the information on rifle manufacture here given is of wide application. The aim throughout this article has been to deal with fundamental principles, which cover laying out the work, designing the tools and gages, and planning the order of operations. A complete analysis has been given of the most efficient method of machining each component part, and the selection of locating, clamping and gaging points for the various operations. In addition, principles of fixture, gage and tool design have been included to make the analysis complete, but this latter part will be treated in a following number of MACHINERY.

Preparing for the manufacture of military rifles includes the writing of instructions and the compilation of a part and material list. This list gives a part number for every part so as to simplify the routing of the work through the plant. The list also carries a designation that indicates the heat-treating process, finish, etc., to which each part must be subjected. The manner in which these specifications are handled will be explained later.

Personnel of the Organization

In order to make the following discussion clear to those unfamiliar with the organization necessary to manufacture a military rifle, it has been thought advisable to approach this subject from the standpoint of an entirely new organization.

Fig. 23. American Springfield Military Rifle, Model 1903

In this way, the most approved methods of designating and organizing the various departments can be followed. This description is necessarily brief, and is confined to an outline of the departments and their functions.

The entire operation of a plant which is to produce 200 military rifles in eight hours should be under the general direction of a works manager, and affiliated with him should be a chief engineer and production or planning engineer. These two separate heads then control all the manufacturing and engineering activities of the entire organization, reporting to the works manager. In the following is given a short description of the duties of each of the important departments and officials in charge of them. The duties assigned to the various department heads differ, and only a very brief outline of a typical organization is given here.

Works Manager—The works manager has complete charge of the plant, and his assistants are the chief engineer and production engineer.

Chief Engineer—The chief engineer has charge of the issuing of all orders covering the manufacture of tools, parts, assembling of parts, shipping, inspection, etc. Duplicate copies of all purchasing orders are forwarded to the production engineer for his guidance in meeting promises relating to production. The chief engineer, acting through the chief draftsman, has sole charge of the designing and construction of all tools, fixtures, etc., including supervision over the tool department as well as the drafting-room, covering the making, issuing and cancelling of all blueprints, inspection and testing of the finished tools, fixtures and gages. He also has charge, through the chief inspector, of the inspection of all finished arms as well as the inspection of the product as it passes from one machining operation to the next. The inspection department acts as a clearing house, checking up quantities as well as qualities of work, and only on the approval of this department will the work be paid for by the pay-roll department. The chief inspector reports to the chief engineer each day on a form designed for that purpose, the lot number, part number, part name, operation number, pieces received, pieces accepted, pieces rejected, per cent rejected, workman's number, workman's name and department number in which the work was done. The testing of the finished rifle and the adjustment and alignment of the sights are performed under the direction of the chief inspector.

Production Engineer—The production engineer, operating through the planning department, has the sole direction of the work of machining and assembling, the latter of which is divided into two departments, one for assembling the parts into groups, and the other for assembling these groups into the completed rifle. The departments covered under the production engineer's control are: cutting-off, forging, annealing and pickling, profiling, milling, drilling, reaming, rifling, straightening, hand milling, screw machine work, punch press work, bluing, hardening, polishing, filing, burring, stocking, assembling of group parts and assembling of completed rifle. He also has charge, working under the direction of the chief engineer, of the time setting and rate setting for all operations on which tests have been made and on which a piece-rate is established. The planning department controls the manufacture, routing and assembling of the work as follows: The work in the machining and assembling departments is controlled through the planning department by the issue of production orders, which are made out in triplicate, one copy being placed on the central control board, another being sent to the department foreman to be placed on the department control board, and the third being sent to the cost department in order to obtain the cost of each lot of parts which is put through the plant. These production orders have a number to which all time and material consumed in the execution of the order must be charged. The planning department, cooperating with the inspection department, also controls the movement of the work and its transfer from one operation to the next, as well as from one department to another. In addition, it is the function of the planning department to study the machining operations and where possible offer suggestions as to a more satisfactory method of handling the work. These must be approved by the production engineer and the chief engineer before any changes can be made.

Plant Engineer—The plant engineer, who is under the direction of the chief engineer, has charge of the installation, erection and repair of all machinery, and the maintenance and upkeep of the buildings and grounds. This department includes belt men, millwrights, truck men, sweepers, watchmen, teamsters, yard laborers, etc.

Cost Clerk—The cost clerk, under the direction of the chief engineer, has charge of the pay-roll and the factory cost accounting. The time cards are cared for by this department, as well as all records showing the work produced at each operation, by whom it is produced and the amount of money due each employe after deducting cost of spoiled work.

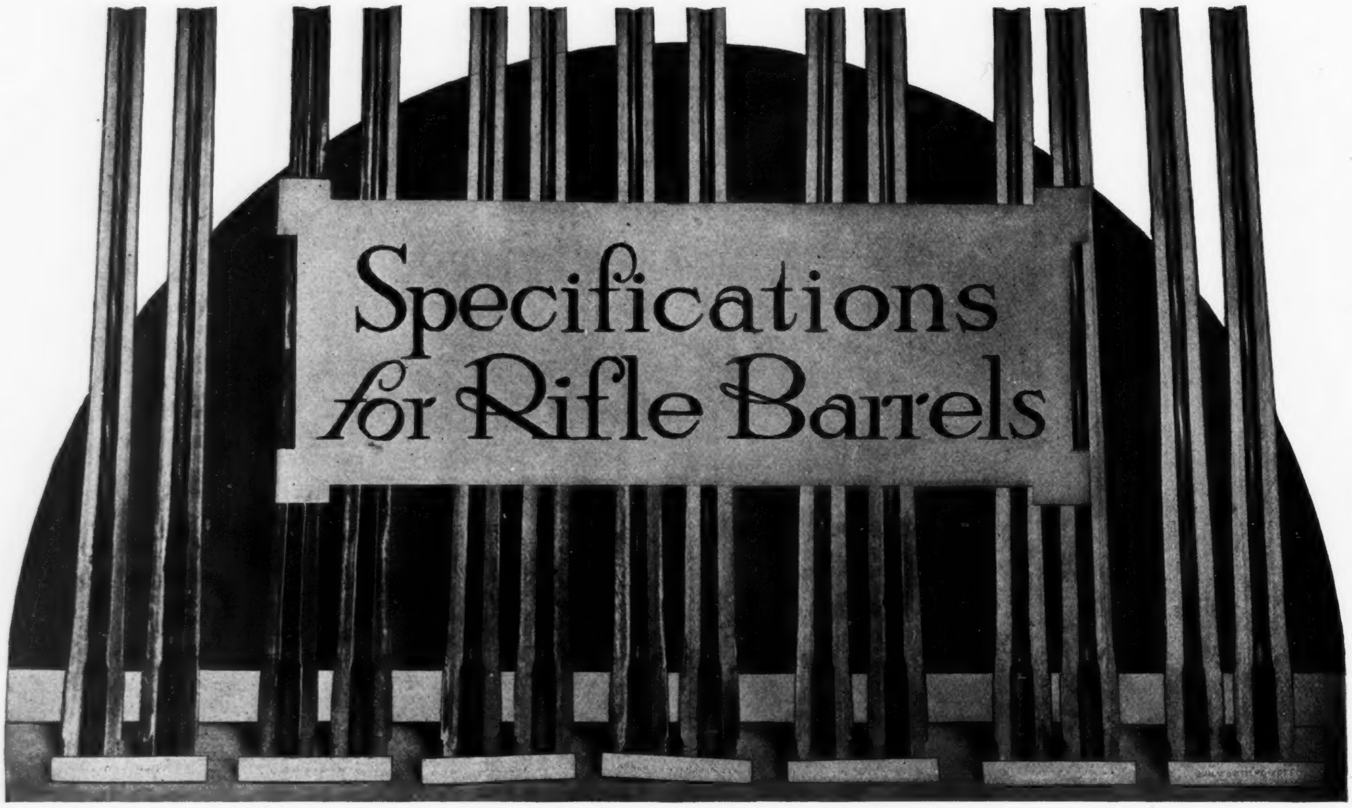
Chief Inspector—The chief inspector, working under the direction of the chief engineer, has full charge of the material from the time it comes into the plant until it is completely machined and assembled, as far as specifications for machining are concerned. No work is passed which does not come up to the specifications and drawings. The inspector is distinctly a functional foreman and a representative of the planning department, and in his special capacity is over every man in the shop. His word is final and his decisions can be set aside by the chief engineer only. The chief inspector should see that rough material such as forgings are examined to be sure that they will finish up to the dimensions given on the drawings. The parts in process are inspected after each operation and before they are moved.

Shop Superintendent—The shop superintendent is in direct charge of the foremen of the manufacturing departments. All department heads under him should have proper written instructions which must be strictly followed. Any improvements that can be made by the planning department in the handling of work should be taken up first with the superintendent and then with the chief engineer. The superintendent should devote his entire attention to the manufacturing departments.

Department Foremen—The department foremen have complete charge of the work under their supervision and their duties are to see that the machines, jigs and fixtures, are kept in proper repair, and that the production department fulfills its duties in removing and passing the work along.

Sub-foremen—It has been found a good plan in large manufacturing departments to install a number of sub-foremen sometimes known as tool-setters. The function of these men, who should be expert operators of the machines over which they have charge, is to set up the various machines on every new job. After the machine has been set up, a completed part is turned out and this is passed upon by the inspector before the operator is allowed to take charge of the machine. The greatest efficiency can be obtained by having a specialist set the machine and then training the operator to handle it in the proper way.

No attempt has been made in the foregoing to cover fully the duties of each of the officials, the object being only to give a general classification of the principal ones.



THE specifications for a military rifle, when turned over to the manufacturer by the war department of the government for whom the rifle is to be manufactured, should be carefully scrutinized by the engineering and production department heads. The requirements on this work are so stringent that it is necessary for the engineering department to give the specifications a great amount of study, before designing any fixtures, tools or special machinery for manufacturing the various parts.

In order to give some idea of the necessary requirements, a brief abstract is given of the specifications required for the Spanish Mauser rifle, caliber 7 millimeters, model 1896.

1. The rifle shall be finished in every respect to the satisfaction of the inspector appointed for that purpose. He shall be at liberty to inspect personally or by deputy the work during its progress, and to reject any unsuitable or defective material that does not agree with the standards set in the specifications.

2. The quality of the material specified shall conform to the instructions given in all cases, and no advantage shall be taken of any omission of detail in these specifications. Full explanation of any part of the work not fully shown or understood can be obtained upon application to the war department.

3. The rifle must conform to the pattern and standard gages, subject to the usual limits and the dimensions as laid down on the working drawings.

4. The inspection shall be carried on in the contractor's or sub-contractor's premises. Suitable accommodations must be provided for by the contractor.

5. If one-fourth of any delivery of any component part be found inferior to the pattern or model or contrary to the terms of this specification, the whole consignment will be liable to rejection.

Specifications for Manufacture of Material

The chemical and physical specifications covering the various materials used in rifle manufacture are given in Tables II and III, respectively. These tables also contain the symbols used to indicate the carbon and manganese content of the material. The chemical and physical requirements of these materials are as follows:

C Steel.—This material has a medium carbon content of about 0.35 per cent, and a high manganese content of 1.20 to 1.30 per cent, low in phosphorus, silicon, and sulphur. It has been used in the manufacture of certain parts for the Springfield rifle, such as the bolt, receiver, bolt plug, cocking-piece, etc. This material, when properly annealed after rolling or forging, machines easily, and when pack-hardened a very hard exterior surface is secured with a soft core. The high manganese content improves the physical qualities and at the same time neutralizes the harmful effect of the phosphorus and sulphur. It also makes the crystals of the steel smaller, and forms a stronger and more homogeneous forging. It is necessary to anneal this steel before performing any operations upon it; for annealing, the steel must be heated to a temperature of from 10 to 20 degrees above the lowest absorption point of the steel, or to about 1285 degrees F. This makes the steel easy to work, and keeps the grains as small as possible. It has been found that by increasing the carbon content of this material, an unsatisfactory material is obtained. It is not only more difficult to machine, but receivers made from it have been found to develop cracks during firing tests. The carbon content should not be above that given in Table II. The method of heat-treating is given under the heading "Pack-harden."

Gun Steel.—This steel, which should be low in carbon and medium in manganese content, is used in the manufacture of such parts as the sight bases, sights, trigger, retaining bolt, etc. In fact, it is used for all parts where the wear is not excessive and where cyanide hardening is satisfactory. Materials covered under these specifications must be manufactured by the crucible or open-hearth process, and must be delivered in the annealed condition. All slabs, blooms, billets, bars or forgings must be rolled or forged from ingots, the cross-section of which is at least four times that of the finished bar or billet, and from which an amount equal to at least 5 per cent of the total weight has been taken from the bottom and 30 per cent from the top if top-poured; and 5 per cent from the bottom and 20 per cent from the top of the ingot if bottom-poured or fluid-compressed. The billet, ingots or forgings must be free from cracks, seams, slivers, flaws or other injurious imperfections, and must have a workmanlike finish and conform to the dimensions given on the drawings. When cold-rolled or cold-drawn materials of these chemical specifications are required, the requirements outlined under the heading "Screw Stock" must be observed.

TABLE II. CHEMICAL CONSTITUENTS OF MATERIALS USED IN MILITARY RIFLE PARTS

Trade Name of Material	Specification Symbol	Limits in Chemical Composition, Per Cent							
		Carbon	Manganese	Silicon	Phosphorus	Sulphur	Chromium	Vanadium	Nickel
C steel	32-120	0.30-0.35	1.20-1.30	0.05-0.10	0.06 max.	0.06 max.	....	....	....
Gun steel	15-72	0.10-0.20	0.55-0.90	0.03-0.08	0.12 max.	0.10 max.	....	....	....
Crucible or lockwork steel	75-35	0.70-0.80	0.30-0.40	0.08-0.20	0.03-0.06	0.02-0.04	....	....	....
Best grade tool steel	118-28	1.10-1.25	0.20-0.30	0.08-0.20	0.03 max.	0.03 max.	....	....	....
Spring steel, carbon	100-32	1.00-1.05	0.30-0.35	0.02-0.10	0.03 max.	0.03 max.	....	....	....
Drill rod	120-22	1.15-1.25	0.15-0.30	0.10-0.40	0.015 max.	0.02 max.	....	....	....
Screw rod	15-45	0.10-0.20	0.30-0.60	0.04-0.10	0.12 max.	0.12 max.	....	....	....
Cold-rolled steel	14-45	0.10-0.18	0.30-0.60	0.05-0.10	0.045 max.	0.05 max.	....	....	....
Smokeless barrel steel	45-120	0.40-0.50	1.15-1.30	0.18-0.25	0.08 max.	0.06 max.	....	....	....
Vanadium, Type D, mild	39-80	0.35-0.43	0.70-0.90	0.20 max.	0.04 max.	0.04 max.	0.80-1.10	0.16 min.	....
Nickel barrel steel	35-65	0.30-0.40	0.50-0.80	0.10-0.20	0.04 max.	0.04 max.	....	....	3.25-3.75
Music wire	57-45	0.55-0.60	0.40-0.50	0.09	0.018	0.011	....	....	....

Machinery

Crucible or Lockwork Steel.—This steel is used in the manufacture of such parts as the safety lock and band spring catch. It is a medium carbon steel capable of being hardened. It must be manufactured by the crucible or open-hearth process and delivered in the annealed condition. The remarks regarding the process of manufacture of gun steel apply also here. The hardening and tempering consist first, in heating the parts to 1450 degrees F. and cooling in oil; second, placing in a wire basket and immersing in a niter bath kept at a constant temperature of 600 degrees F. The parts are kept immersed until they reach the temperature of the bath, the time required varying with the size of the part.

Tool Steel.—Tool steel of the best grade is used in the striker, which is subject to considerable wear. It can be manufactured either by the open-hearth, crucible or electric furnace process. From each lot of twenty bars or a fraction thereof of the same size, made from the same open-hearth melt or furnace charge, three bars are selected at random and subjected to physical tests. Bars that do not vary in their cross-sectional dimensions more than 1/8 inch will be considered one size. The material is subjected to a chemical analysis to determine the percentage of the chemical constituents, especially the carbon content. The front end of the striker only is hardened. This part is heated to 1450 degrees F., immersed in oil, and then drawn in a niter bath to 450 degrees F.

Spring Steel, Carbon.—This material is used in the manufacture of the flat springs, which are not subjected to excessive wear or severe stress. Carbon spring steel does not give as good results for rifle parts as vanadium type D steel, and consequently carbon spring steel is only used where the service is not severe. The specifications on this material permit it to be manufactured by the open-hearth, crucible, or electric furnace process. The chemical constituents must agree with those given in Table II. The percentage of vanadium or other elements may vary so long as the necessary physical requirements are maintained, in which case only the percentage of phosphorus and sulphur need conform closely to that given in the table. The nick test and deflection test shall be made with a full size specimen. Tensile tests shall be made with a full size specimen when practicable. Each test specimen must be taken from a different bar. For the tensile test, a specimen bar after being tempered shall have an ultimate tensile strength of at least 150,000 pounds per square inch, with an elastic limit of at least 85 per cent of the ultimate tensile strength. For the nick test, a specimen shall present a fine uniform grain when nicked and broken. For the deflection test, a specimen bar after being tempered, and resting upon supports 24 inches between centers, shall not take a permanent set of more than 0.05 inch after the first application of a load corresponding to a fiber stress of 115,000 pounds per square inch; nor a permanent set of more than 7.5 per cent of the total deflection on a load producing a fiber stress of 140,000 pounds per square inch; nor any further set after five additional applications of the load giving a fiber stress of 130,000 pounds per square inch. This steel must be free from all defects. The bars shall be thoroughly cleansed by pickling or other approved methods, and when cleansed by pickling they must be thoroughly washed in limewater and rinsed with fresh water to remove all traces of the pickling bath. In the case of round bars a variation of 0.02 inch in diameter is allowed on bars over 7/16 inch diameter; and in the case of rectangular bars a variation of 0.02 inch in thickness and 0.03 inch in width is allowed on bars over 3/16 inch in thickness and 7/16 inch in width.

Drill Rod.—This material is used in the manufacture of such parts as pins, etc., and when these parts are subjected to wear, they are hardened and tempered, as specified in Table IV. The material known as drill rod must conform to the chemical analysis given in Table II and to the physical specifications given in Table III. The rods shall be smooth and polished, and cut to lengths as ordered, and shall have smooth ends and be in strict accordance with the sizes called for. A variation of not more than 0.0005 inch is allowed on all sizes under 7/16 inch diameter.

Screw Rod.—This material is used in the manufacture of such parts as screws, bushings, butt plate, etc., and is used in its natural condition without casehardening. The material may be cold-rolled or cold-drawn at the option of the manufacturer, but must be free from defects and have a smooth and workmanlike finish. For rods or bars up to 1/2 inch diameter or thickness, the cold reduction must not be less than 1/32 inch, and for rods or bars greater than 1/2 inch the cold reduction must not be less than 1/16 inch. The limits on the diameter or thickness of the finished material are as follows: For bars up to and including 1 inch, 0.003 inch; above 1 inch and including 2 1/2 inches, 0.004 inch; above 2 1/2 inches

TABLE III. PHYSICAL PROPERTIES OF MATERIALS USED IN MILITARY RIFLE PARTS*

Trade Name of Material	Specification Symbol	Tensile Strength, Pounds per Square Inch	Elastic Limit, Pounds per Square Inch	Reduction of Area, Per Cent	Elongation in Two Inches, Per Cent	Scleroscope Hardness Numeral
C steel	32-120	85,000-100,000	56,000-65,000	35-60	25-35	34-37
Gun steel	15-72	60,000-80,000	40,000-55,000	40-60	30-35	28-33
Crucible or lockwork steel	75-35	80,000-95,000	46,000-54,000	45-55	25-35	29-33
Best grade tool steel	118-28	95,000-105,000	50,000-60,000	20-30	15-20	31-36
Spring steel, carbon—untreated	100-32	100,000-110,000	54,000-65,000	20-30	5-8	33-37
Spring steel, carbon—heat-treated	100-32	150,000-160,000	130,000-150,000	....	....	53-58
Drill rod	120-22	120,000-130,000	100,000-120,000	25-35	5	47-52
Screw rod	15-45	85,000-100,000	68,000-85,000	45-60	25-35	38-43
Cold-rolled steel	14-45	65,000-85,000	45,000-75,000	45-60	30-40	29-41
Smokeless barrel steel	45-120	100,000-120,000	60,000-75,000	40-55	20-30	36-41
Vanadium, Type D, mild—untreated	39-80	85,000-110,000	65,000-85,000	45-60	20-25	37-43
Vanadium, Type D, mild—heat-treated	39-80	150,000-200,000	135,000-180,000	45-55	8-15	55-65
Nickel barrel steel—untreated	35-65	85,000-100,000	52,000-68,000	45-65	20-25	33-39
Nickel barrel steel—heat-treated	35-65	115,000-175,000	90,000-160,000	55-65	10-20	45-60
Music wire	57-45	275,000-340,000	......	....	....	65-75†
Walnut, English or American	W	......	......	....	....	....
Gum wood	W	......	......	....	....	....

Machinery

*Courtesy of the Henry Souther Engineering Co.

† Music wire cannot be compared with ordinary heat-treated steel because of the peculiar mechanical working that it is subjected to during the process of manufacture.—Shore Instrument Co.

0.005 inch. The limits for the chemical and physical requirements are given in Tables II and III, respectively. For testing this material, it is divided into four groups as follows: The dimensions given refer to the diameter of round rods and the thickness of rectangular bars. Group 1: ¼ inch; group 2: ¼ inch and up to ½ inch; group 3: over ½ inch and up to 1½ inch, inclusive; group 4: over 1½ inch. For groups 1, 2 and 3 the elastic limit must not be under 75,000 pounds per square inch and for group 4, not under 70,000 pounds per square inch. The phosphorus or sulphur content must not exceed 0.06 per cent. The bending test specimen must be taken at a distance of one-fourth the diameter of the bar from the longitudinal axis. When bent cold to 180 degrees, the inside diameter of the bend must not be greater than three times the diameter of the bar being tested. The allowable variations in thickness, width or diameter are up to and including 1 inch, 0.003 inch; above 1 inch and including 2½ inches, 0.004 inch; above 2½ inches, 0.005 inch.

Cold-rolled Steel.—Cold-rolled steel is used in the manufacture of such parts as the stock mortise band and upper band nose plate. It must be a flanging, cupping and drawing steel and must be made by the open-hearth process. It must also be soft and ductile, of low-carbon content, with a bright finish, and must be flat and of uniform thickness. It must stand blanking, cupping and drawing to a depth of four inches in four drawings. After cutting or trimming to length, it must stand forming by having the open end reversed, turning it inside out as tinners do when wiring cans. All this work must be done with punches and dies. The material must be made of such ductility that it can pass from one drawing operation to the next without annealing and with losses that do not exceed 2½ per cent.

Smokeless Barrel Steel.—The greater number of rifle barrels made at the present time are produced from a special material known as smokeless barrel steel, the chemical and physical properties of which are given in Tables II and III, respectively. This steel is generally used in the untreated condition, as it has been found by numerous experiments that heat-treating does not improve it, but seems to make it more subject to corrosion. Corrosion in a rifle barrel always starts about ½ to 1 inch from the point where the end of the cartridge case terminates in the breech of the barrel, and continues on toward the muzzle. Corrosion sometimes takes place gradually, or it may skip the center of the barrel and start in again at the muzzle. Smokeless barrel steel seems to be the least affected by the corrosive action of nitro powders of any of the steels thus far used. It is manufactured by the crucible or open-hearth process in a similar manner to other carbon steels. Stock for rifle barrels is generally 1.35 or 1 5/16 inch diameter. The chemical and physical requirements must be closely adhered to.

Vanadium Type D Mild.—This alloy steel has been found to give excellent results in springs subjected to severe duty. It is manufactured either by the electric, crucible or open-hearth process, and the remarks regarding manufacture made in reference to best grade tool steel also apply here. The maker is requested to specify the heat-treatment necessary to obtain the best physical condition in order that it may resist tensile, crushing or vibratory stresses, and also the heat-treatment necessary to produce a high degree of hardness when required. This steel is recommended for use in the extractor, retaining bolt spring, rear sight leaf spring, extractor collar, etc. These parts are all hardened at the same temperature but are drawn to different temperatures, as they have different functions to fill. For hardening, the pieces are heated and quenched in oil at about 1600 degrees F. They are then drawn at temperatures varying between 750 and 840 degrees F.

Nickel Barrel Steel.—The great demand for smokeless barrel steel has made it necessary for some manufacturers to substitute 3½ per cent nickel steel. The chemical and physical requirements necessary are given in Tables II and III, respectively, and the manufacture is either by the open-hearth or crucible process, the crucible process generally being used for rifle barrels. This steel is used in the heat-treated condition. A few degrees variation in the temperature at which the steel is heat-treated makes a great variation in the resulting physical properties, and hence great care must be taken in heating the pieces thoroughly and uniformly throughout. For rifle barrels, the material is generally heat-treated by first being heated to 1425 to 1440 degrees F., at which temperature it is held for 1½ hour, and then quenched in oil. When cold, it is reheated to 1020 to 1045 degrees F. for 1½ hour, and then allowed to cool off in the furnace.

Music Wire.—Music wire is used for all coil springs and especially for the main spring, sear spring, etc. For rifle springs the treatment consists in immersing the parts in a niter bath heated to 470 degrees F. until they reach a straw color, when they are removed and cleansed in water.

Specifications for Machining Operations on Rifle Parts

The specifications covering the machining of the steel parts deal principally with the tolerances or limits allowed; these vary from ± 0.0025 inch for some parts to ± 0.00025 inch for other parts where good fits are necessary. There are also a few other important points such as hardened surfaces, location of holes, etc., that must receive careful attention. In the following is given a brief outline of the requirements for the principal parts.

The receiver is gaged for size and shape, position of thread and locking shoulder from the barrel seating, positions of slots, ejector hole, sear pin hole, charger guide, sear nose slot, cocking-piece slot, and tang. The bolt is gaged for size and shape, and tested for straightness and concentricity of bore, also for position of lever, locking shoulder, and cams, and all hardened surfaces are tested. The striker is gaged for size and shape of point and position of collar. The striker is tested for temper by placing the point in a hole and applying a pull of seven pounds immediately above the collar, after which it is spun to be certain that it runs true. The cocking-piece is gaged for diameter, width, shape, position and diameter of cam. The magazine spring is compressed for a period of not less than fourteen hours slightly in excess of the amount of compression to which it is subjected in the magazine, after which it must lift the plunger to the stop with a weight slightly greater than the weight of five loaded cartridges. The main spring is compressed for a period of not less than fourteen hours slightly in excess of the amount of compression to which it is subjected in the rifle.

Treatment and Finish of Parts

One of the first duties of the engineering department after studying the specifications is to designate part numbers for the various components of the rifle. This is generally done according to the group system, dividing the rifle up into four or more units, such as the barrel and assembly, receiver and assembly, bolt and assembly, magazine and trigger guard and assembly, stock and miscellaneous parts. The parts are then given consecutive numbers in this order. This simplifies the ordering of material and the routing of the work. Symbols are also used for the chemical constituents of the material. The usual manner in which this is done is to take the highest content of the two principal ingredients. For instance, in a 50-point carbon, 60-point manganese steel, the symbol would be 50-60. Thus instead of specifying the entire chemical constituents of the steel in the shop order, these symbols alone are given. In some manufacturing plants letters are used instead of numbers to refer to the chemical constituents, but this is not as satisfactory, as the numbers are practically self-explanatory. In Table IV, which gives a complete list of the parts with their part numbers, is also included a column giving the kind of material used for the various parts, the specification symbol, treatment and finish. In designating the various heat-treatments and finishing operations, the first two letters of the word are used as a symbol. When a compound word, such as pack-hardening, designates the operation, the first letters of each part of the compound are used, such as PH or ST for special tempering.

In the following are given a list of the symbols for the heat-treatments and finishing operations, and a description of each process. The operations described are referred to by the symbols given in Table IV.

An = Anneal	Oi = Oil
Bg = Blue (Gas Furnace Process)	PH = Pack-harden
Bn = Blue (Niter Bath Process)	Pi = Pickle
Br = Browning (Rusting)	Po = Polish
CH = Caseharden	ST = Special Tempering
Cl = Clean	Te = Temper
Ha = Harden	Tu = Tumble

Symbol An: Anneal.—This treatment is given to parts that are rough-formed to shape by forging. Rifle parts, such as the receiver, bolt, trigger guard, and other smaller parts, after forging and trimming, are packed in cast-iron boxes containing charred bone, and the cover is luted with fireclay. The box and contents are heated in the furnace at a temperature slightly above the critical point, which varies with the chemical constituents in the steel. Parts containing from 0.50 to 0.80 per cent carbon should be heated to a temperature varying from 1250 to 1300 degrees F., then taken out and allowed to cool off in the boxes. The barrel is annealed by packing in an annealing furnace and heating to about 1300 degrees F. It is then removed and placed in a sand box where it is allowed to cool off gradually.

Symbol Bg: Blue (Gas Furnace Process).—This process makes use of the special gas furnace developed by the American Gas Furnace Co., in which the work is placed on special racks and then loaded in the rotating cylindrical retort. The retort is rotated at a speed of from 2 to 5 R. P. M., depending upon the size of the work. The capacity of this drum is for 125 pounds of work and sixteen quarts of granulated charred bone in sizes of from 1/8 to 1/4 inch granules. Before the work is put into the retort, the torch should be lit and adjusted so as to produce a soft blue flame about 1 1/4 inch long with a slightly green core at each burner tip. In about one hour's time the thermometer should read from 625 to 700 degrees F., which is the proper heat at which most work should be blued. The work is now inserted with eight quarts of charred bone, but without the "carbonia oil." After the articles have been thoroughly oxidized, which requires about one hour, eight quarts of charred bone are thoroughly mixed with one pint of "carbonia oil," thus making a total of sixteen quarts of bone in the retort. It is important that the bone and carbonia be thoroughly mixed, and to facilitate this they should first be warmed. If this precaution is not taken the work is likely to become spotted. The retort is now rotated, and the work exposed to the action of this mixture with the thermometer registering about 625 degrees F. for a time varying from one-half to three hours, depending on the shape and surface finish of the pieces. In order to determine the correct color, a few pieces should be taken out of the retort and examined. When first removed they appear gray, but when dipped in oil and wiped off or tumbled in oily cork, they show deep black or carbonia finish. The pieces should be examined every half hour for each new batch of work, so that the bluing operation need not be carried on any longer than necessary to get the desired color. The total time required for each charge is about five hours.

When discharging the retort, the bone is sifted from the work and the latter dumped, if small parts, into wire baskets and submerged in sperm oil. For work having small grooves, holes, etc., it is preferable instead of dipping the work in the oil to tumble it in cork which has been saturated with sperm oil. After the work is sufficiently cool, the basket should be raised from the tank, and the oil allowed to drip off. The finish-drying is then done in sawdust or in any suitable manner for the work in hand. The drying may also be done in the retort of the machine with sawdust or ground cork; ground cork is preferable, but if sawdust is employed it should be free from very fine dust, as this forms a paste which clogs up the screw threads, slots, small holes, etc. Heavy articles which demand the very best finish should not be removed from the retort until the heat has been allowed to decrease sufficiently to prevent oxidization of the carbonia finish. It should also be understood that firearm parts should not be tumbled loose in the retort but should be held on fixtures or racks. The retort of this furnace will hold approximately eighty pieces of the size of the receiver, magazine or trigger guard, to each charge, and one operator can attend to about six furnaces. The fuel used is illuminating gas, and the consumption per hour for the No. 64 heating furnace is between 90 and 100 cubic feet.

Symbol Bn: Blue (Niter Process).—This treatment is given all small parts or those of minor importance. The nitrate of potassium (saltpeter) is melted in an iron tank and heated to about 600 degrees F. The parts to be blued are cleansed and placed in a wire basket, after which they are immersed in the molten niter until a uniform color of the desired shade is obtained. This immersion requires only a few seconds. The articles are then removed and cleansed in water, after which linseed oil is applied to prevent them from rusting.

TABLE IV. LIST OF RIFLE PARTS GIVING SYMBOLS USED IN SPECIFYING MATERIAL, TREATMENT AND FINISH

No. of Part	Name of Part	Kind of Material	Specification Symbol	Treatment and Finish
1	Barrel	Steel Forging	45-120	An-Pi-Po-Br
2	Front Sight	Steel	15-72	Po-Bn
3	Front Sight Base	Steel	15-72	Po-Bn
4	Front Sight Base Screw	Steel	15-45	Po-Bn
5	Rear Sight Base	Steel Forging	15-72	An-Pi-Po-Bn
6	Cleaning Rod	Steel	15-45	Use as mach'd
7	Rear Sight Leaf	Steel	15-72	Po-Bn
8	Rear Sight Leaf Spring	Steel	39-80	Ha-Po-Te 750° F.
9	Rear Sight Leaf Spring Screw	Steel	15-45	Po-Bn
10	Rear Sight Leaf Pin	Steel	120-22	Po-Bn
11	Rear Sight Slide	Steel	15-72	Po-Bn
12	Rear Sight Slide Catch	Steel	15-72	Po-Bn
13	Rear Sight Slide Catch Pin	Steel	120-22	Ha-Po-Te 600° F.
14	Rear Sight Slide Catch Spring	Music Wire	57-45	ST
15	Rear Sight Slide Catch Stop Screw	Steel	15-45	Po-Bn
16	Receiver	Steel Forging	32-120	An-Pi-PH-Po-Bg
17	Retaining Bolt	Steel	15-72	CH-Po-Bn
18	Retaining Bolt Spring	Steel	39-80	Ha-Po-Te 750° F.
19	Ejector	Sheet Steel	100-32	Ha-Te 600° F.
20	Ejector Fulcrum Screw	Steel	120-22	Ha-Te 600° F.
21	Bolt	Steel Forging	32-120	An-Pi-PH-Po-Bg-Po
22	Bolt Plug	Steel Forging	32-120	An-Pi-PH-Po-Bn
23	Cocking Piece	Steel	32-120	PH-Po-Bn
24	Striker	Steel	118-28	Ha-Te 450°-Po
25	Extractor	Steel	39-80	Ha-Te 750°-Po
26	Extractor Collar	Steel	39-80	Ha-Te 750°-Po
27	Main Spring	Music Wire	57-45	ST
28	Safety Lock	Steel Forging	75-35	An-Pi-Ha-Te 600°-Po-Bn
29	Magazine and Trigger Guard	Steel Forging	15-72	An-Pi-Po-Bg
30	Magazine Floor Plate	Steel Forging	15-72	An-Pi-Po-Bn
31	Floor Plate Catch	Steel	15-72	CH
32	Floor Plate Pin	Steel	120-22	Ha-Te 600° F.
33	Floor Plate Spring	Music Wire	57-45	ST
34	Magazine Platform	Steel Forging	15-72	An-Pi-Po-Bn
35	Magazine Spring	Steel Ribbon	100-32	Ha-ST 740°-Cl
36	Stock	Wood	W	Oi
37	Hand Guard	Wood	W	Oi
38	Butt Plate	Steel Forging	15-72	Po-Bn
39	Sear	Steel	75-35	Ha-Tu-Te 600° F.
40	Trigger	Sheet Steel	15-72	CH-Po-Bn
41	Sear Pin	Steel	120-22	Ha-Po-Te 600° F.
42	Sear Spring	Music Wire	57-45	ST
43	Trigger Pin	Steel	120-22	Ha-Po-Te 600° F.
44	Stock Mortice Band	Sheet Steel	14-45	Po-Bn
45	Guard Screw, Front	Steel	15-45	Po-Bn
46	Guard Screw, Rear	Steel	15-45	Po-Bn
47	Guard Screw Bushing	Steel	15-45	Use as machined
48	Butt Plate Screw, Lower	Steel	15-45	Po-Bn
49	Butt Plate, Screw Upper	Steel	15-45	Po-Bn
50	Butt Sling Swivel	Steel	15-45	Po-Bn
51	Butt Sling Swivel Block	Steel	15-72	Po-Bn
52	Butt Sling Swivel Pin	Steel	120-22	Ha-Te 600° F.
53	Butt Sling Swivel Block Screws (two)	Steel	15-45	Po-Bn
54	Lower Band	Steel Forging	15-72	An-Pi-Po-Bn
55	Lower Band Spring Catch	Steel	75-35	Ha-Te 600° F. Po-Bn
56	Lower Band Swivel	Steel	15-45	Po-Bn
57	Lower Band Swivel Screw	Steel	15-45	Po-Bn
58	Lower Band Swivel Screw Nut	Steel	15-45	Po-Bn
59	Upper Band	Steel Forging	15-72	An-Pi-Po-Bn
60	Upper Band Spring Catch	Steel	75-35	Ha-Te 600° F. Po-Bn
61	Upper Band Nose Plate	Sheet Steel*	14-45	Po-Bn
62	Upper Band Nose Plate Pin	Steel	120-22	Ha-Te 600° F.

* Electrically welded.

Symbol Br: Browning.—The browning process is applied to parts that cannot be heated after being finished. It consists in cleaning the work thoroughly in boiling limewater, after which the residue of lime is removed by a hand-brush. The browning fluid is applied with a sponge, after which the parts are allowed to "rust" by being placed in an oven, the air in which is moistened by the escape of steam through perforations in the steam pipes. Care is taken to see that all sections of the work where browning is not desired are protected by wood plugs. After the parts are thoroughly rusted, they are

scratch-brushed, and the rusting and scratch-brushing operations are repeated until three or four coats of rust have been applied. As a final treatment, oil is applied to prevent further rusting of the parts. A satisfactory browning fluid comprises the following constituents:

Constituent	Part by Ounces
Spirits of wine (grain alcohol)	1½
Tincture of iron	1½
Corrosive sublimate (mercury chloride)	1½
Spirits of niter (nitrous ether)	1½
Blue vitriol (copper sulphate)	1
Nitric acid	¾

Dissolve the corrosive sublimate in one quart of warm water and add the blue vitriol; then add the alcohol, tincture of iron, spirits of niter, and finally the nitric acid.

Symbol CH: Caseharden.—This treatment is given parts that require a surface hardness and in which strength and resiliency are minor considerations. The work is immersed in a bath of molten cyanide of potassium, and heated to a temperature of from 1450 to 1500 degrees F. for from one to five minutes, depending on the character of the work being treated. The work is then removed and cleansed in water.

Symbol Cl: Clean.—This treatment is given to parts after machining to remove the oil and fine chips. The solution used is known as a hot soda bath, and is kept in iron kettles. A satisfactory cleaning solution is composed of one-half pound sal-soda to each gallon of water. The solution is heated to the boiling point before immersing the parts to be cleansed. Small parts are usually held in wire baskets for immersing. The time required for cleaning depends upon the condition of the work. When thoroughly cleansed, the work is removed and allowed to dry off, the soda deposit preventing the parts from rusting. As caustic soda is a strong alkali, care should be taken to prevent it from getting onto the hands.

Symbol Ha: Harden.—This treatment is given where called for and is applied only to parts having a carbon content of over 0.65 per cent. It consists of heating the parts to be hardened above the recalescence point and immersing in water or oil, depending on the cross-sectional area of the part and the possibility of its warping out of shape.

Symbol Oi: Oil.—This treatment consists of the application of raw linseed oil to the finished stock and hand-guard in as many coats as are required to produce the finish desired. The oil is allowed to penetrate into the wood after each coat before the following coat is applied.

Symbol PH: Pack-harden.—This treatment is given to parts that have a severe duty to perform but cannot be subjected to the treatment given under symbol Ha, owing to their carbon content. The treatment consists in packing the work in casks or wrought iron boxes, using a mixture of charcoal and charred leather. Care should be taken to see that the pieces of work do not touch the surfaces of the container or each other. Bone should not be used, as it contains a high percentage of phosphorus, which tends to make the steel weak and brittle. These boxes are then placed in the furnace and heated to about 1500 degrees F., after which they are removed, the work is taken out and immersed in water or oil. Great care should be exercised in heating, not to allow the temperature to exceed that specified, as a higher heat coarsens the grain and necessitates reheating.

Symbol Pi: Pickle.—This treatment is given to forged parts previous to machining to remove the scale, and is also given to some parts after hardening. The pickling solution, which is composed of one part sulphuric acid to ten parts water, is contained in wood or lead-lined tanks. The acid should be poured into the water while stirring, but the water should never be added to the acid, as this may cause an explosion. The sulphuric acid bath does not attack the sand or black oxide of iron which forms the scale, but soaks through and attacks the iron beneath the scale, dissolving it sufficiently to loosen it. The best and quickest results are obtained by heating the pickling solution, but in no case should the temperature exceed 150 degrees F., as a higher temperature than this causes noxious fumes. After the scale is loosened sufficiently, which generally requires from thirty minutes to an hour, the parts should be immersed in the hot soda solution used for cleaning to remove all traces of acid. The best results are obtained by heating both the pickling and soda baths.

Symbol Po: Polish.—This operation follows machining and in some cases heat-treatment of the parts. The object of polishing is to obtain a smooth finished surface on the work. The number of polishing operations given the work depends upon the condition of the surface left by machining, and also to some extent on the size and shape of the part. Some parts, such as screws and other small parts, are rough- and finish-polished; others slightly larger or of medium size are given three polishes, whereas parts such as the receiver pass through as many as four polishing operations. The polishing wheels vary in diameter from 1 to 18 inches, depending upon the size and shape of the work. Small wheels of 1 or 2 inches diameter are made from walrus hide turned to the form required, but larger ones are made with wooden cores to the periphery of which leather or walrus hide is glued. Leather used for covering wood core wheels is oak-tanned triple ply leather belting of the best grade. Walrus hide is used for wheels of small diameter on which a form is turned that would cause trouble if made from belt leather. The speeds of the wheels vary from 4500 to 5000 surface feet per minute, depending upon the size of the wheel and the character and shape of the work being polished.

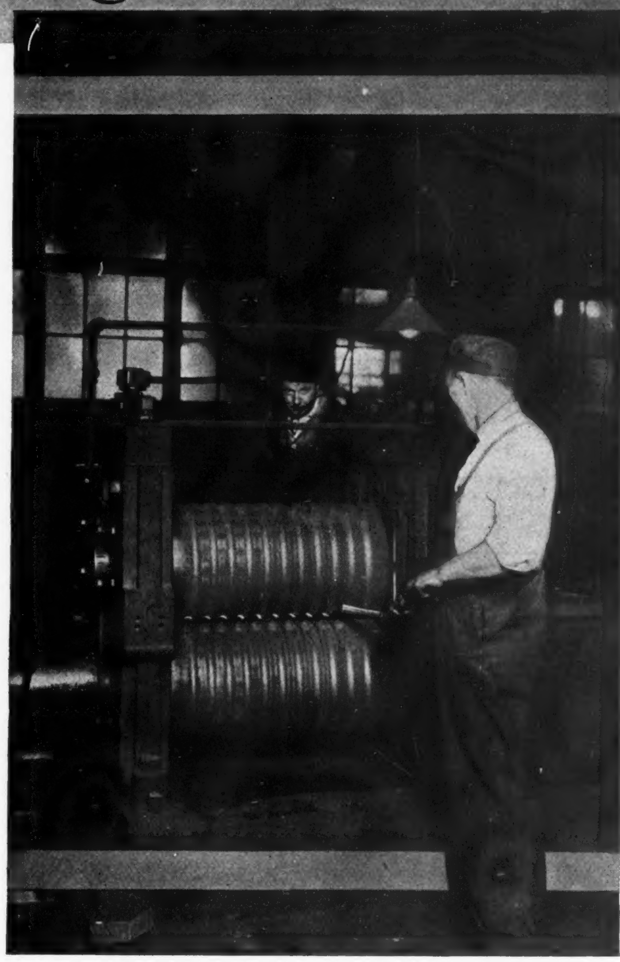
The grades of emery used for polishing operations vary with the condition of the work. If the machining has been properly done, using cutters which have been carefully sharpened, the polishing operation is accomplished with the minimum of labor, and a finer grade of emery can be used. The polishing operation on the large parts, such as the receiver, comprise the following: roughing, first fining, second fining and finishing. In general, the rough-polishing is done with No. 90 emery; the first fining with No. 120 emery; the second fining with the wheel used for the first fining, which has been worn down smooth, or with a new wheel charged with No. FF emery; and the finishing with wheels charged with No. FF emery, after being stoned down to a smooth surface to avoid scratching the work. For finishing, the face of the revolving wheel is oiled with oil-soaked waste held in thin cloth covers. Light machine oil is generally used for this purpose. The stones used for smoothing the surface of the wheel are common hard white pebbles.

Symbol ST: Special Tempering (Springs).—This treatment is given such parts as coil springs, including the main spring, sear spring, etc. It consists in immersing the work in a niter (saltpeter) bath which has been heated to 470 degrees F., in which the parts are allowed to remain until they reach a "straw" color; they are then removed and cleansed in water. The special heat-treatment of coil springs made of music wire is peculiar to the firearms industry.

Symbol Te: Temper.—This treatment is given all hardened parts in order to relieve the strain set up in the hardening operation. It consists in placing the parts in a wire basket and immersing them in a niter bath kept at the required temperature. In using this symbol, the required temperature is noted as a part of the symbol itself. For example, the retaining bolt spring, made of vanadium type D mild steel, is tempered to 750 degrees F.

Symbol Tu: Tumble.—This treatment is given to the smaller parts in order to remove the hardening scale and sharp edges, and consists in placing the parts in a tumbling barrel together with a quantity of steel balls of various sizes in the proportion of one peck of work to two pecks of steel balls. Soapy water is then poured into the barrel until it rises about one inch above the surface of the work. The amount of burnishing soap chips used for each charge is about four ounces, and this should be dissolved before the water is poured in. The barrel is then rotated at about 15 R. P. M. for a period of from one to five hours, depending on the condition of the work when placed in the barrel and the results required. After tumbling, the contents are removed by emptying onto a screen through which the balls pass; then the work is washed in a hot soda solution, after which it is ready for the succeeding operations.

Machining Barrels and Sight Parts



PREVIOUS to the advent of smokeless powder, military rifle barrels were made from low-carbon steel, and were not heat-treated. Round stock turned to the required external size and shape, and drilled, reamed and rifled was generally used. Soft steel was found unsuitable for use with smokeless powders, and other steels containing higher percentages of carbon and manganese were used to better withstand the erosive effects; thus a special steel known as "smokeless barrel steel" has come into prominence. It is recommended for this barrel, and stock 7/8 inch in diameter is used. These special steels are more difficult to work than cold-rolled steel, and various methods have been adopted, not only to save material, but also to reduce the machining time. One method is to upset the end of the barrel at the breech, so that smaller diameter stock can be used. Another is to roll the barrel tapering in a taper-rolling machine of either the continuous or half-roll type.

There are two methods used in taper-rolling rifle barrels, employing two distinct types of machines. The older type, which was first used in the Springfield armory about the time of the Civil War, comprises two rolls, shown by the diagram in Fig. 24, with a series of eleven grooves on their periphery. These rolls are about 20 inches in diameter, and the grooves are tapering, being practically the diameter of the rough stock at the beginning and gradually tapering down to the end. The rolling starts, of course, at the deepest part of the groove. Seven passes of the bar through the rolls are required to finish it. The bar is heated in an oil furnace to a temperature of about 1380 degrees F., a low temperature being found to be best. When the bar has reached the correct temperature, it is quickly removed from the furnace and placed in the rolling machine. It requires two men to operate this rolling machine; one feeds the bar in at the front and the other catches it at the rear and passes it back again. One man has charge of the furnace and one operates the drop-hammer for straightening the barrels. Straightening is done by using an upper and lower die, each of which has a half groove in its surface, which is slightly longer than the barrel and made to a similar taper. The barrel is laid in the lower groove and the hammer dropped while the bar is being rotated; this acts as a rough outside straightening operation. The production from one rolling machine is about 400 barrels in eight hours, requiring the services of four men.

This method of rolling, while in general use, has several disadvantages. First, it requires a skilled operator to accomplish the work satisfactorily. Second, it is difficult to roll a barrel straight because the heated bar is easily twisted while being entered between the grooves in the rolls. Again, the barrel rolls away from instead of toward the operator, making it difficult for him to keep it straight when passing through the rolls; in addition, the machine cannot be worked at its full capacity because of the difficulty of catching the roll each time it turns around. The production, therefore, is not as great as that which is obtained by the half-roll machine, which is described in the following.

An improved method of rolling rifle barrels has been developed by the Ajax Mfg. Co., Cleveland, Ohio. The chief advantage of this method is that the barrel is rolled toward the operator instead of away from him, and the machine can be operated by one man. Another advantage is that the work can be easily placed in position, and the operator has no difficulty in "catching the rolls." Placing the work against the stop also makes it easier for the operator to produce a straight barrel. Fig. 25 shows how this is accomplished. The method of operating this machine is to place the heated barrel in the guide and against the stop when the half rolls are furthest apart. Then as the rolls rotate they drive the bar out in the direction indicated by the arrow, presenting it to the operator, who simply supports it and prevents it from dropping down. The most convenient method is to use a bar of sufficient length to make two barrels, and taper it down at each end, cutting it apart in the center. The rolls are operated at 30 R. P. M., and for an average barrel are provided with seven grooves which are of practically the same diameter as the rough bar and gradually decrease to the smallest section of the barrel.

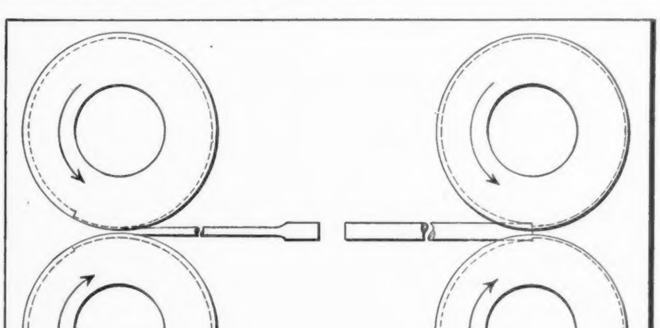


Fig. 24. Continuous Roll Method of rolling Rifle Barrels

The rolls used on this machine are provided with both single- and double-adjustment roll-holders. The former have a vertical adjustment to allow for rolling different diameters of stock and to permit finishing the rolling dies when they become worn. The latter have both vertical and eccentric adjustment. The eccentric adjustment is accomplished by loosening the set-screws on one side of the shaft and tightening those on the other so as to shift the roll into an eccentric position. Thus, straight annular grooves may be used for rolling tapers by setting the dies eccentrically as shown by the diagram. The back-stop provided with the machine regulates the length to which the stock is inserted between the dies, thus securing accuracy in handling. On the average rifle barrel, the production obtained from this machine is about 800 in eight hours, two men being employed, one to attend to the furnace and the other to the rolling machine.

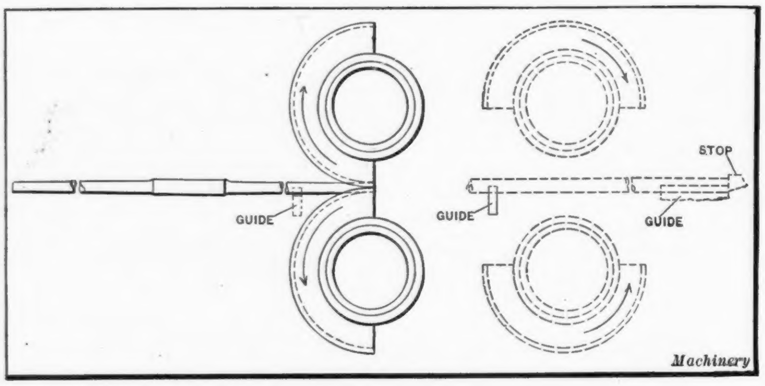


Fig. 25. Ajax Method of rolling Rifle Barrels

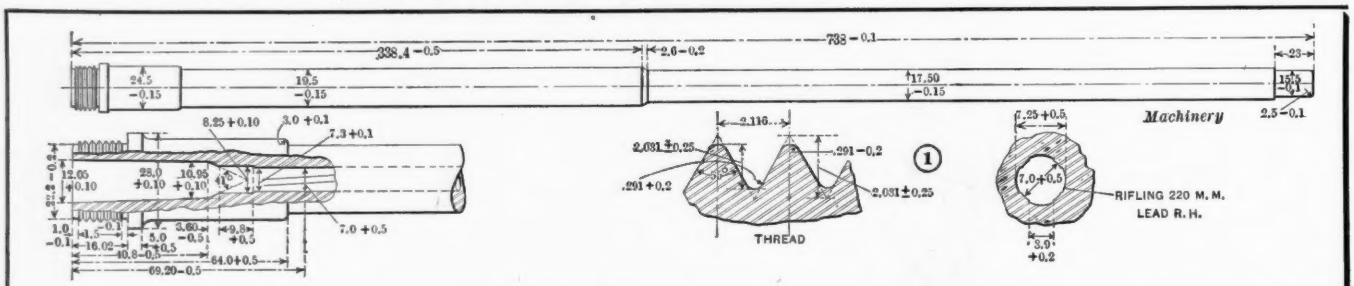
Upsetting Rifle Barrels

Another method of making rifle barrels which applies particularly to the barrel used on the Spanish Mauser rifle is to upset the breech end. This is accomplished in an upsetting and forging machine and is usually done in one blow. Unless the operation is handled carefully, however, one blow is not sufficient to give a homogeneous upset, and it is recommended that in all cases two blows be used. The method of accomplishing this is simple and is described briefly in the order of machining operations on the barrel. All barrels are annealed after rolling and then pickled. These operations have been covered separately.

Operations on Barrel

The barrel is considered by military experts to be the most vital part of a rifle, and as such receives very careful attention during the process of manufacture. Aside from the character of the material used, the two most important points are the concentricity and straightness of bore. The most satisfactory method of machining is to start with the bore and then locate from the bore for all subsequent external machining operations. The following description, in connection with Table V and Figs. 27 to 31, gives a complete outline of all the important operations on this rifle barrel.

TABLE V. OPERATIONS ON BARREL—PART NO. 1



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off	Cold sawing mach.	Higley saws	31	0.075	60	3
2	Upset breech end	2-inch power forg. mach.	Dies and plunger	70 strokes	Hand	135	1
3	Anneal and pickle	Annealing furnace	See text	..	..	30	1
4	Turn, face and center breech end	Turret lathe	Air chuck and tools	65	Hand	25	1
5	Straighten outside	..	Hand fixture	..	..	20	..
6	Drill	Gun barrel drill. mach.	0.265 gun barrel drill	100	0.00057	3	4
7	Ream bore, rough	Gun barrel ream. mach.	0.269 barrel reamer	15	0.040	15	2
8	Countersink each end	Whiton double-head centering mach.	60 deg. countersink	75	Hand	50	1
9	Spot-turn	Engine lathe	..	120	Hand	25	1
10	Rough-turn	Gun barrel turn. lathe	Steadyrest and tools	120	0.002	4	6
11	Straighten (interior)	..	Hand oper.	..	..	15	1
12	Ream bore, first finish	Gun barrel ream. mach.	0.273 barrel reamer	16	0.040	15	2
13	Turn breech end	Engine lathe	..	120	Hand	35	1
14	Grind shoulder on muzzle	Cylindrical grind. mach.	Grinding wheel	Wheel 5000 Work 35	Hand	40	1
15	Grind, second setting	Cylindrical grind. mach.	Grinding wheel	Wheel 5500 Work 40	Power	25	1
16	Grind, finish	Cylindrical grind. mach.	Grinding wheel	Wheel 5500 Work 42	Power	20	1
17	Ream bore, finish	Gun barrel ream. mach.	0.2756 sq. reamer	15	0.040	15	2
18	Straighten (interior)	..	Hand oper.	..	..	15	1
19	Rifle	Gun barrel rifling mach.	Hook cutter "Intra" steel	30	0.0005 per trav.	1½	4
20	Counterbore and ream chamber	Gun barrel chambering mach.	1 counterbore 4 reamers	20	Hand	4	1
21	Finish muzzle end	Chambering machine	Spec. fixt.	30	Hand	30	1
22	Mill thread for receiver	Thread mill. mach.	Spec. fixt.	60	..	30–40	3
23	Mark inscriptions	Noble & Westbrook mark. mach.	Roll stamp	..	Hand	30	1
24	Polish	Polishing lathe	Leather covered wheels	3500 R.P.M.	Hand	5 to 6	1
25	Brown	Browning oven	Circular trucks	..	..	25	4 men
26	Polish muzzle	Screw shav. mach.	Emery cloth	150–200	Hand	60	1

Machinery

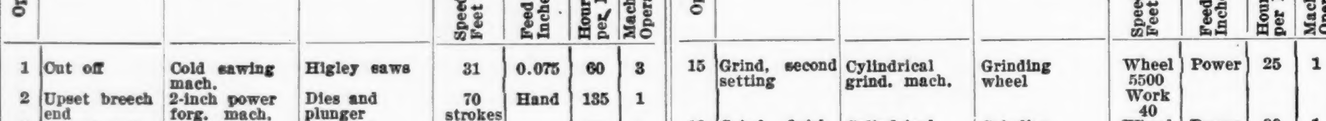


Fig. 26. Spanish Mauser Rifle Barrel and Sight Bases

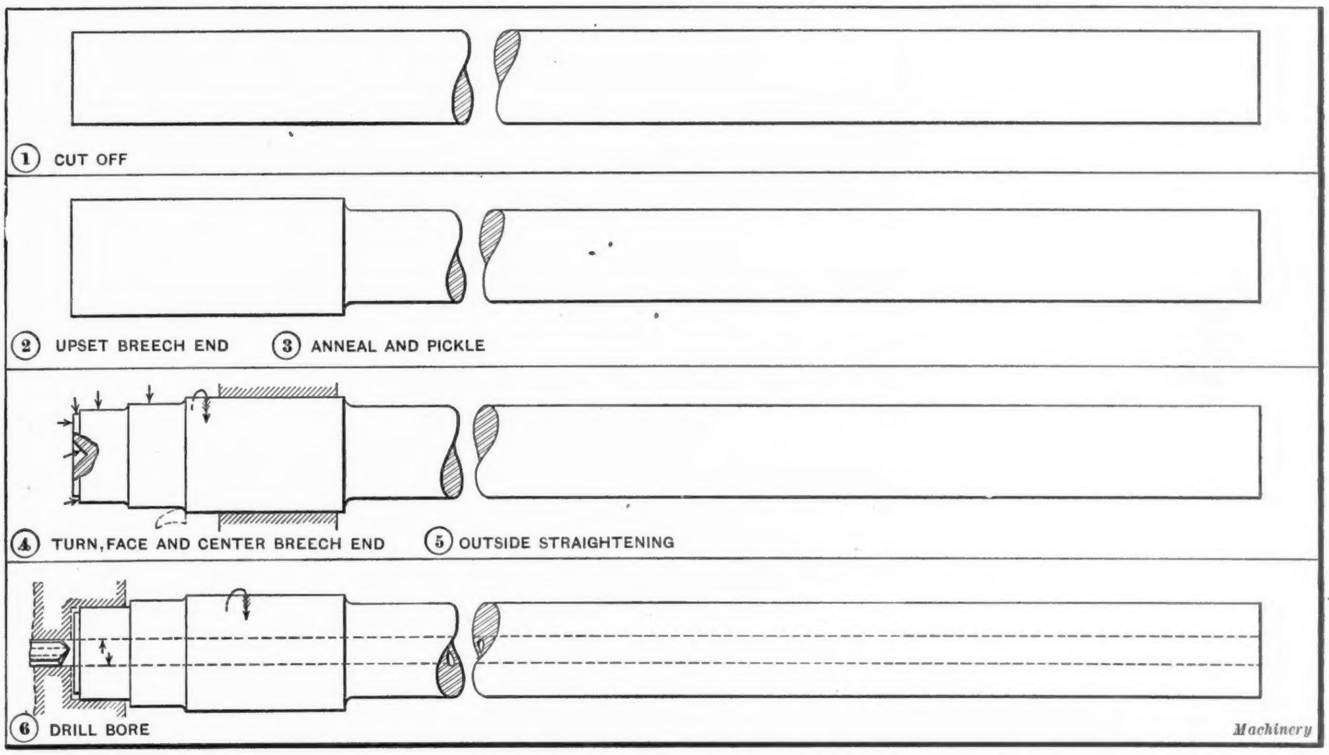


Fig. 27. Operations on Spanish Mauser Rifle Barrel

Operation 1: Cut Off.—This operation is accomplished in a cold-sawing machine in which six bars are held at one setting. A high-speed steel inserted-tooth saw should be used.

Operation 2: Upset Breech End.—This operation is accomplished in a two-inch upsetting and forging machine. The bars of stock are placed in a gas furnace and heated on one end for a distance of about six to eight inches, to approximately 1500 to 1600 degrees F. One operator is required to attend to the furnace and the other to operate the forging machine. On this size of upset one blow is generally sufficient, but in order to secure a more homogeneous structure, it is advisable to give the work two blows. The hourly production, employing two men, one furnace and one machine, is about 135 pieces.

Operation 3: Anneal and Pickle.—Annealing of the rifle barrels is done in a muffle furnace. The barrels are heated in the furnace until they reach a uniform temperature of from 1200 to 1300 degrees F. throughout, and are then removed and placed in a sand box to cool off slowly. (See also "Anneal.") The pickling is necessary to remove the scale formed in annealing and facilitate machining. (See "Pickle.")

Operation 4: Turn, Face and Center Breech End.—This is a preparatory machining operation. The end of the barrel is turned down at the breech so that it can be held in the bushing in the barrel drilling machine. The centering is done to facilitate starting the oil-tube drill. The work is gripped in an air chuck and the machining operations are performed from the turret and cross-slides.

Operation 5: Straighten Outside.—In order to reduce the amount of subsequent straightening, it is advisable, previous to drilling the bore, to straighten the outside surface of the barrel. This is accomplished in the usual manner by placing

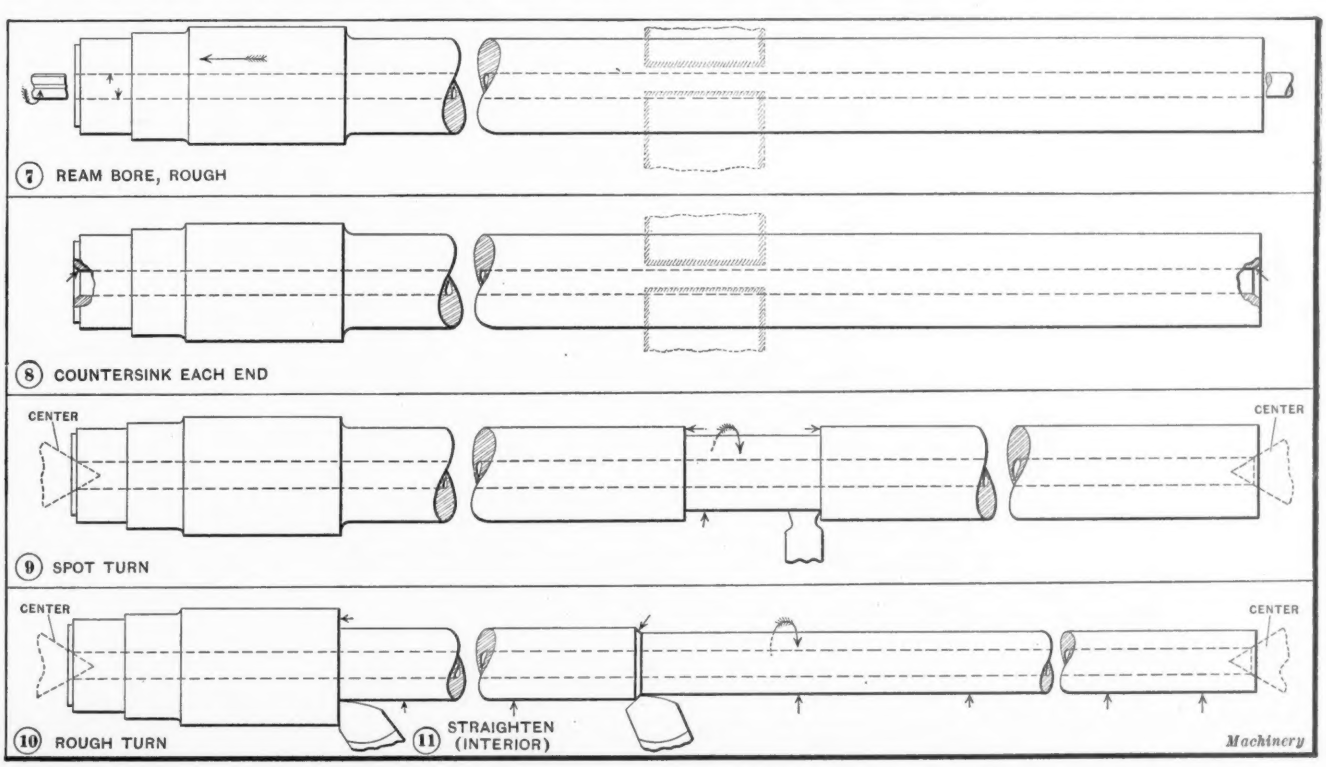


Fig. 28. Operations on Spanish Mauser Rifle Barrel (Continued)

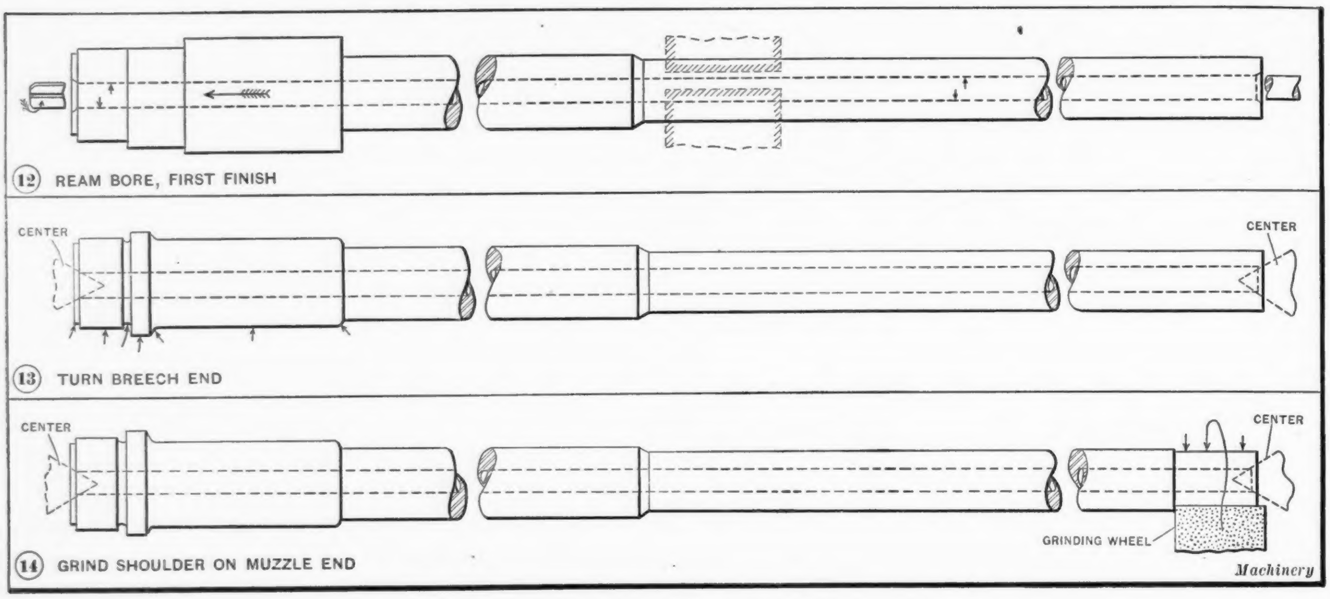


Fig. 29. Operations on Spanish Mauser Rifle Barrel (Continued)

the bar on a support and striking it where crooked with a hammer. It is then rolled on parallel strips to determine whether it is straight or not.

Operation 6: Drill.—This operation is performed on a standard barrel drilling machine, the barrel rotating instead of the drill. The barrel is rotated at a high rate of speed—about 1760 R. P. M.—and the forward feed of the drill is about 0.00057 inch per revolution of the work. Good lard oil or other effective cooling lubricants are forced through the drill at a pressure of about 450 pounds. This high pressure is necessary in order to force the chips back through the groove in the drill.

Operation 7: Ream Bore, Rough.—This operation is performed in a regular gun barrel reaming machine which differs from the drilling machine in that the work is held stationary and the reamer rotated. The most satisfactory method of reaming a gun barrel is to hold the barrel in a "floating" fixture, and then draw instead of push the reamer through. This facilitates reaming and reduces the liability of producing a bore with reamer rings in it. The reamer is held in a chuck, and is generally of the four-fluted type, with teeth having a negative rake.

Operation 8: Countersink Each End.—This operation is generally accomplished on a double-head centering machine of the "Whiton" type. The work is held in a "floating" fixture in the center, and a countersinking tool in each spindle countersinks the bore to provide centers for turning.

Operation 9: Spot-turn.—This operation is accomplished in an engine lathe, and the object is to provide a center point by which the barrel can be supported by a steadyrest when rough-turning. Owing to the flexibility of the barrel, this operation cannot be accomplished very readily, and care should be taken to see that all barrels are turned to the correct diameter.

Operation 10: Rough-turn.—This is done in a regular gun barrel turning lathe, in which the barrel is held on centers, and supported by a steadyrest at the center. Two cross-slides carry the turning tools. One operates at the muzzle end, and the other on the opposite side of the steadyrest, working toward the breech end.

Operation 11: Straighten Interior.—This operation is accomplished by hand by a barrel straightener. There are two methods in general use. The first known as the "line shadow" method is the older, but is still used in many rifle barrel plants. A strip of wood nailed across a ground glass placed over the window casts two shadows down the bore of the

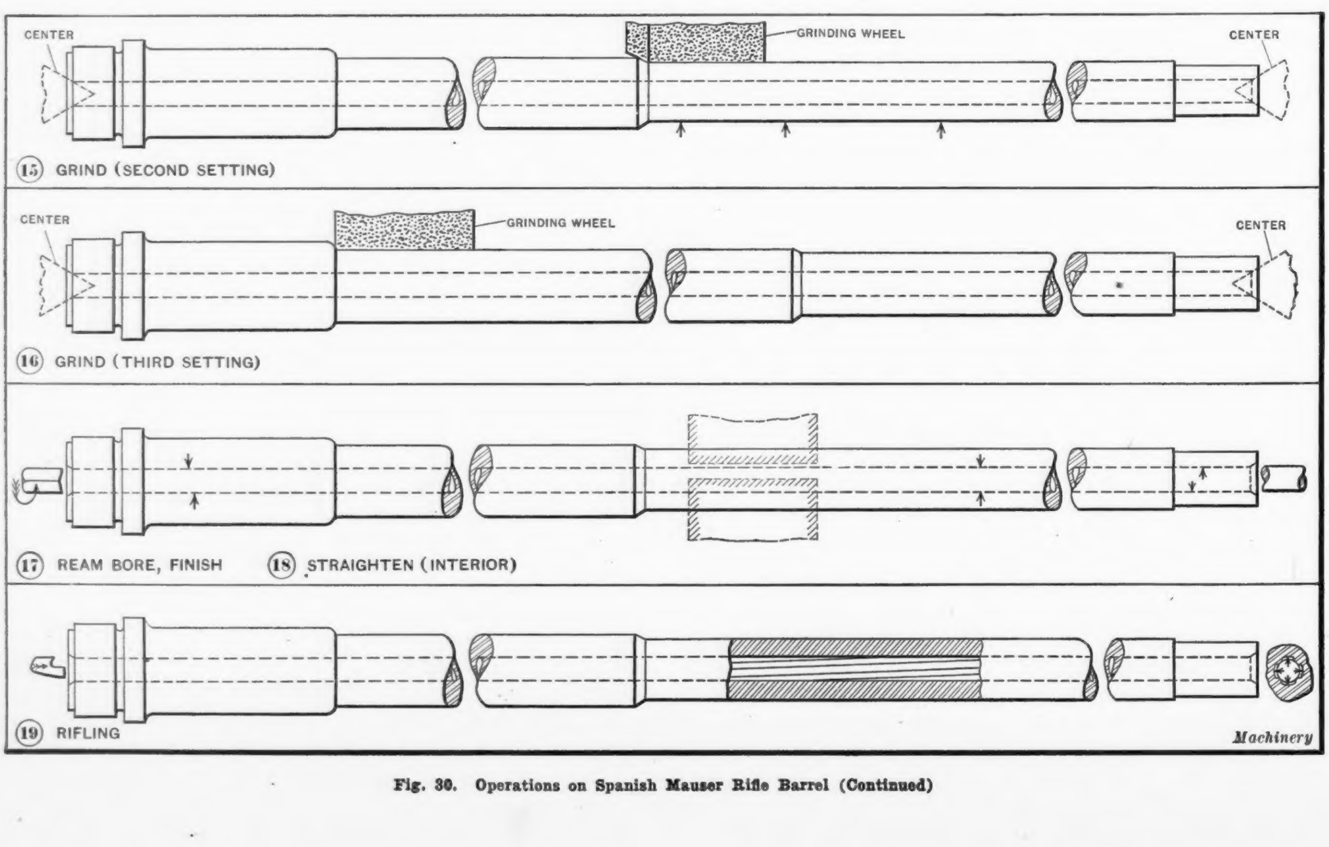


Fig. 30. Operations on Spanish Mauser Rifle Barrel (Continued)

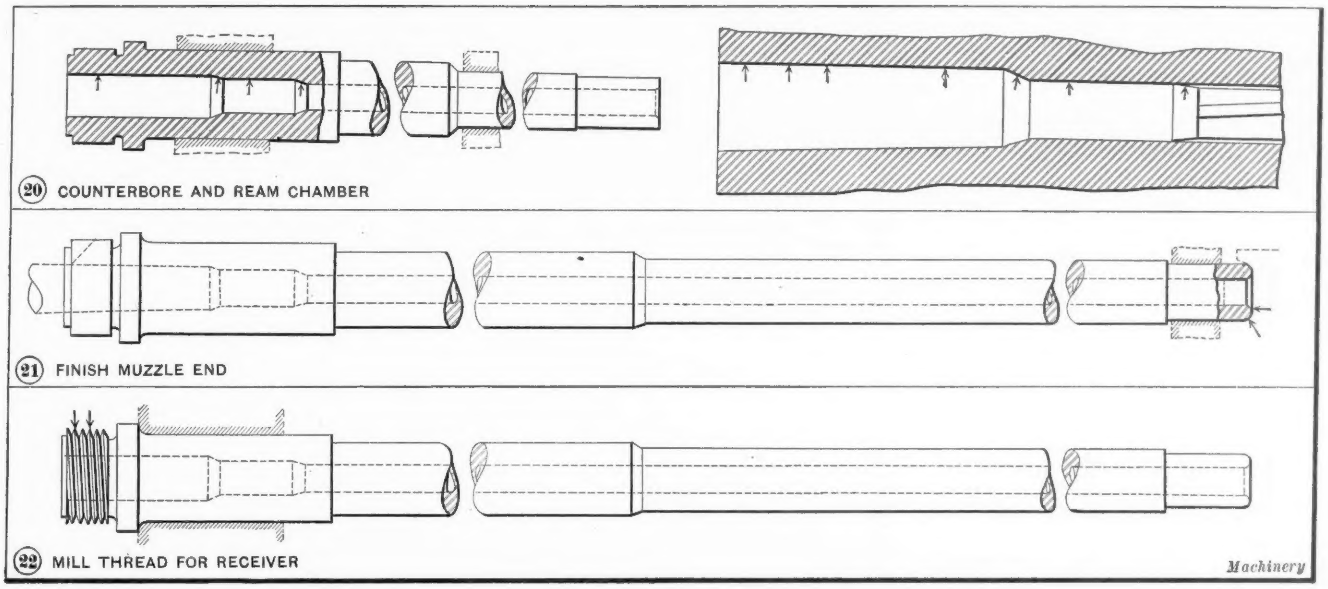


Fig. 31. Operations on Spanish Mauser Rifle Barrel (Continued)

barrel. Any bend or curvature in these line shadows indicates a corresponding lack of straightness at that point in the bore. The barrel is then straightened until the shadows are parallel. This method requires the barrel to be reversed, because the shadows diffuse at a distance a little beyond the center of the barrel. The more modern method is that known as the "concentric ring" method. In this, a lens is placed in the muzzle of the barrel, which is covered with cement through which a circle is scratched to the glass. When the barrel is held up to the light, a series of rings appears in the bore of the barrel. By suitable regulation of the amount of light permitted to strike the muzzle, this can be made an extremely delicate test, and the slightest want of concentricity is an indication that some correction is needed. For further information on this subject, see article entitled "Drilling, Reaming and Straightening Rifle Barrels" in another part of this number.

Operation 12: Ream Bore, First Finish.—This operation is accomplished in a similar manner to Operation 7.

Operation 13: Turn Breech End.—This operation consists in reducing the diameter at the breech end which is subsequently to be threaded, facing the end, under-cutting at the shoulder, and turning that portion not turned in the previous operations.

Operation 14: Grind Shoulder on Muzzle.—This operation is performed in a plain cylindrical grinding machine and consists in grinding that portion of the muzzle end on which the front sight base is to be soldered. This diameter is ground by feeding the wheel straight in on the work without any lateral traverse.

Operation 15: Grind, Second Setting.—This operation is also performed in a plain cylindrical grinding machine, and consists in grinding the portion extending from the shoulder at the muzzle end up to the first increase in diameter. This operation is done by traverse grinding.

Operation 16: Grind, Finish.—This is also done in a plain cylindrical grinding machine and consists in finish-grinding the last long shoulder on the barrel.

Operation 17: Ream Bore, Finish.—This operation is performed in a similar manner to Operation 7, except that a square reamer is used. Oil is placed on the reamer, and a rosewood shim is held in one of the grooves by a washer. This shim backs up the reamer and keeps the cutting edge at all times in contact with the work. The square type of reamer is one of the oldest reamers used for this operation, and is conceded to be the most satisfactory. This operation should be very carefully handled. The gaging is done by dropping a plug 0.275 inch diameter, and six inches long, through the entire length of the barrel. The gage must not be forced through, but must drop through freely from its own weight.

Operation 18: Straighten Interior.—This is handled in the same manner as Operation 11, but must be much more carefully done, as it is the final straightening operation.

Operation 19: Rifle.—This operation is accomplished in a regular barrel rifling machine. Two different types of cutters are used for this work—one known as the "scrape," and the other as the "hook" cutter. Some authorities claim that the scrape cutter gives the best results, but this is not agreed upon. It is certain, however, that the hook cutter works much better than the scrape type. The former works on the return stroke, and the latter works on both forward and return strokes, but takes much lighter cuts.

Operation 20: Counterbore and Ream Chamber.—This operation is accomplished in a barrel chambering machine, using counterbores and reamers. The usual practice is to use one counterbore of the eccentrically relieved type, having three diameters, and then finish the bore by using four reamers, each slightly larger than the foregoing, the final one covering all diameters. This operation must be very carefully handled, to make the chamber concentric with the bore and also to prevent throwing up burrs into the rifling grooves, which would necessitate lapping. The most satisfactory gun barrel is one that has a machine-finished bore—not lapped.

Operation 21: Finish Muzzle End.—This operation, performed in a gun barrel chambering machine, consists in using an eccentrically relieved cutter, which chamfers the inside and outside of the muzzle end, in order to prevent the formation of burrs.

Operation 22: Mill Thread for Receiver.—This operation is accomplished in a thread milling machine employing a special fixture.

Operation 23: Mark Inscriptions.—This is done in a Noble & Westbrook marking machine, using a roll stamp on which the required inscriptions are cut in relief.

Operation 24: Polish.—This operation is accomplished on a polishing lathe and consists in using two different grain sizes of emery glued to a leather-faced wheel. For the roughing operation, No. 60 emery is used, and for the finishing, No. 90. The speed of the wheel is about 3500 revolutions per minute.

Operation 25: Brown.—See "Brown."

Operation 26: Polish Muzzle.—This operation is accomplished by gripping the barrel in a screw shaving machine and using No. 120 emery cloth to brighten up the muzzle.

OPERATIONS ON FRONT SIGHT

The front sight (see Fig. 32), which is subjected to very little wear, is made from a bar of gun steel, and for the preliminary operations is cut off into lengths of five inches. These bars, which should preferably be of cold-rolled, rectangular stock, 1/2 by 11/32 inch, are ground all over preparatory to milling. After rough-milling to form the blade, the bar is cut up into ten parts and at the same time the dovetail is rough-milled. The previously ground surfaces act as locating and gaging surfaces in the subsequent operations. For additional details, such as feeds, speed and production, see Table VI.

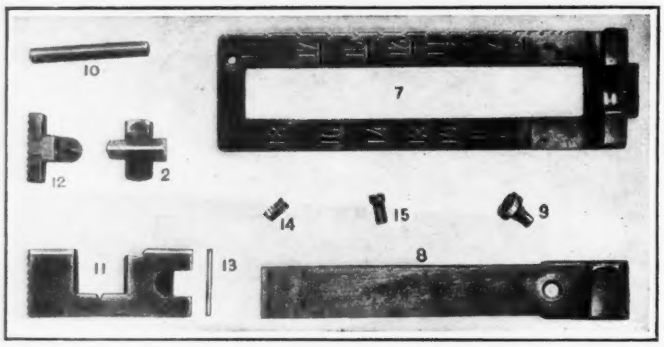
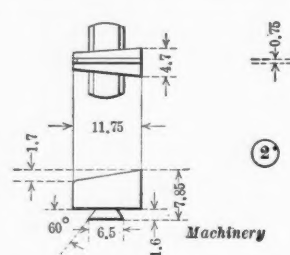


Fig. 32. Rear and Front Sight Parts

Operation 1: Cut into Lengths of 5 Inches.—This operation is accomplished on a cutting-off machine that holds six bars at once, using a high-speed steel inserted-tooth saw.

Operation 2: Grind Top and Bottom.—This is done on a Blanchard vertical surface grinder, using a magnetic chuck that has an outside retaining ring and holds eighty pieces. 0.010 to 0.015 inch is removed from each side, the limit being 0.002 inch. The wheel used is silicate, corundum, grain 30,

TABLE VI. OPERATIONS ON FRONT SIGHT—PART NO. 2



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut into lengths of 5 in.	Cutting-off mach.	Insert. tooth H. S. steel saw	40	0.20	1000	2
2	Grind top and bottom	Blanchard surf. grinder	Magnetic chuck	See text		2000	1
3	Grind right- and left-hand sides	Blanchard surf. grinder	Magnetic chuck	See text		2000	1
4	Mill blade and top	Lincoln type mill. mach.	Spec. fixt. holds two strips	70	0.015	200	3
5	Cut off from bar and mill dovetail, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.010	150	2
6	Mill front and rear ends	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	25	2
7	Mill angles of dovetail projection	Hand mill. mach.	Spec. indexing fixt.	75	Hand	45	1
8	Mill angle on top	Hand mill. machine	Spec. vise jaws	75	Hand	50	1
9	Mill right-hand angular side	Hand mill. machine	Spec. vise jaws	75	Hand	45	1
10	Mill left-hand angular side	Hand mill. machine	Spec. vise jaws	75	Hand	45	1
11	Mill dovetail corners	Hand mill. mach.	Spec. rotary fixt. with former	75	Hand	60	1
12	File corners and burr	..	Files	..	..	40	1
13	Polish	Polishing lathe	Leather covered wheels	4500	Hand	80	1
14	Blue	Niter bath	....	..	..	See text	

grade ¾, 16 inches diameter, 1½ inch width of rim. The table feed is roughing, 17 R. P. M.; finishing, 5 R. P. M. The depth of cut per revolution of work-table is 0.001 inch; production, 400 to 500 per hour, for each side.

Operation 3: Grind Right- and Left-hand Sides.—This operation is also accomplished on a Blanchard vertical surface grinder, under the same conditions as Operation 2.

Operation 4: Mill Blade and Top.—This operation is done on a Lincoln type milling machine, using a special fixture that holds two 5-inch strips. A gang of three form cutters is used which rough-mills the tapered sides, top and shoulder.

Operation 5: Cut Off from Bar and Mill Dovetail, Rough.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. In the clamping jaws of the fixture are slots through which the cutting-off saws pass.

Operation 6: Mill Front and Rear Ends.—This is accomplished on a Lincoln type milling machine, using a fixture that holds two pieces. The ends are milled by straddle-milling.

Operation 7: Mill Angles of Dovetail Projection.—This operation is accomplished in a hand milling machine, using a special indexing fixture in which the work can be indexed so that both sides of the dovetail can be milled at one clamping of the work.

Operation 8: Mill Angle on Top.—This is accomplished in a hand milling machine, using special vise jaws in which the work is held at an angle to the travel of the table; one piece is milled at a time.

Operation 9: Mill Right-hand Angular Side.—This operation is done in a hand milling machine, in which the work is held in special vise jaws at an angle to the surface of the table.

Operation 10: Mill Left-hand Angular Side.—This operation is handled in the same manner as Operation 9.

Operation 11: Mill Dovetail Corners.—This is done in a hand milling machine, using a special rotary fixture with a former on the table for controlling the movement of the cutter-head.

Operation 12: File Corners and Burr.—This is a hand operation.

Operation 13: Polish.—See "Polish."

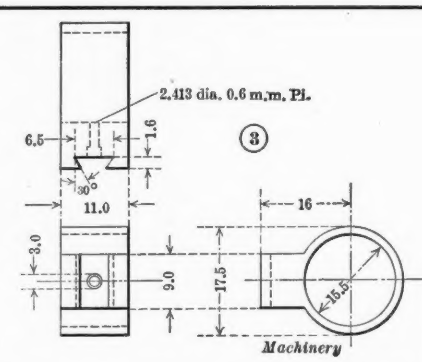
Operation 14: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON FRONT SIGHT BASE

The front sight base (see Fig. 26) is made from a 1⅛-inch round bar of gun steel stock, the first operation being accomplished in an automatic screw machine of the multiple-spindle type. The hole and one end are then used as locating and gaging points in subsequent operations. For milling the dovetail slot in the top, however, a third location point is necessary, the right-hand side being used for this purpose. For additional details, such as feeds, speeds and production, see Table VII.

Operation 1: Drill, Ream, Face and Cut Off.—This operation is accomplished in a multiple-spindle automatic screw ma-

TABLE VII. OPERATIONS ON FRONT SIGHT BASE—PART NO. 3



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drill, ream, face and cut off	Mult. spin. auto. screw mach.	Spec. tools	30 to 85	0.0015 to 0.010	60	3
2	Face opposite end to length	Blanchard surface grinder	Mag. chuck	See text		800	1
3	Mill right- and left-hand outline and top	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.020	45	2
4	Mill sight slot, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.020	100	1
5	Mill sight slot dovetail, finish	Hand mill. mach.	Spec. fixt.	75	Hand	45	1
6	File corners and burr	..	Files	..	..	45	1
7	Polish	Polishing lathe	Leather covered wheels	4500	..	65	1
8	Blue	Niter bath	..	..		See text	

chine, in which the work is held by eccentric chucks. A straight-blade type of cut-off tool is used.

Operation 2: Face Opposite End to Length.—This operation is accomplished in a Blanchard vertical surface grinder, using a magnetic chuck which has a retaining ring that surrounds the work. Four hundred pieces can be held at one time on the chuck; the amount removed from one side is 0.010 inch and the limit is — 0.002 inch. A corundum wheel, grain 30, grade 3/4, silicate, 1 1/2 inch face, 16 inches in diameter, is used. The table speed, roughing, is 17 R. P. M.; finishing, 5 R. P. M. The depth of cut per revolution of work is 0.001 inch.

Operation 3: Mill Right- and Left-hand Outline and Top.—This operation is accomplished in a Lincoln type milling machine, using a special fixture that holds two pieces. The right-hand side, top, and half of the circular section is milled on one side of the fixture and the left-hand side and the remainder of the circular section is machined on the opposite side of the fixture, one piece being completed at each traverse of the table. The fixture used is made with one side adjustable so as to take care of variations in diameter of the cutters. High-speed steel, eccentrically relieved, interlocking form-milling cutters are used.

Operation 4: Mill Sight Slot, Rough.—This operation is also accomplished in a Lincoln type milling machine, using a fixture that holds two pieces. The work is done by an ordinary plain cutter without any teeth on the sides. The same type of fixture is used as for Operation 3.

Operation 5: Mill Sight Slot Dovetail, Finish.—This operation is accomplished in a hand milling machine, using a special fixture and a T-shape dovetail cutter.

Operation 6: File Corners and Burr.—This is a hand operation.

Operation 7: Polish.—See "Polish."

Operation 8: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON REAR SIGHT BASE

The rear sight base (see Fig. 26) is a drop-forging made from a 1 1/8-inch diameter round bar of hot-rolled gun steel. After drop-forging, trimming, annealing and pickling, the first machining operation consists in drilling and reaming the hole and facing the large end in a hand screw machine. In all subsequent operations, the hole and the large end act as locating and gaging points, except when machining the slot, when the right-hand side also serves as a third locating point. For additional details, such as feeds, speeds and production, see Table VIII.

Operation 1: Drop-forge and Trim.—This operation is performed under an 800-pound drop-hammer, a roughing or breaking-down and finishing impression being necessary. The forging is trimmed while hot and cut off the bar.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Drill, Ream and Face.—This operation is accomplished in a hand screw machine, the work being gripped in an air chuck provided with special shaped jaws to grip the piece securely.

Operation 4: Face Front End to Length.—This operation is accomplished in a screw shaving machine, the work being held on a hardened and ground expanding mandrel and forced up against the shoulder; the facing is done by a tool on the cross-slide.

Operation 5: Mill Top Face.—This operation is performed in a Lincoln type power milling machine, provided with a special fixture for holding two pieces.

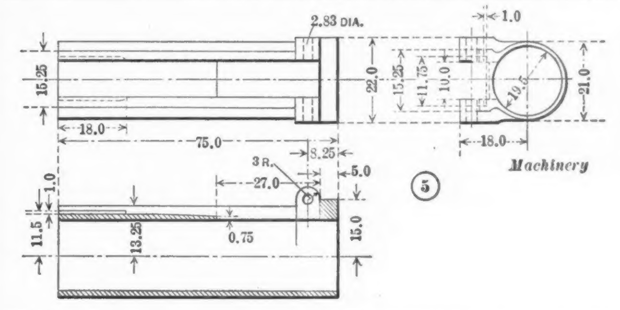
Operation 6: Sweep-mill Outside of Body.—This is done in a Lincoln type milling machine, the fixture being designed to hold two pieces and rotated by a rack on the bed.

Operation 7: Sweep-mill Rear End of Body.—The same remarks apply here as in Operation 6.

Operation 8: Mill Sight Leaf Hinge Lugs and Sides.—This operation is accomplished in a Lincoln type milling machine, a fixture being provided that holds two pieces.

Operation 9: Profile Clearance Cut for Sight Leaf Spring Groove, Rough.—This operation is done in a single-spindle profiling machine provided with a former for controlling the movement of the end-mill. This former is provided with a

TABLE VIII. OPERATIONS ON REAR SIGHT BASE—PART NO. 5



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-lb. drop-hammer	Forging and trimming dies	..	..	60	1
2	Anneal and pickle	Anneal furn. pickling bath	......	..	..	100	..
3	Drill, ream and face	Hand screw mach.	Spec. chuck and tools	30-60	0.010-0.015	20	1
4	Face front end to length	Screw shav. mach.	Spec. chuck	60	0.002	60	1
5	Mill top face	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.020	60	2
6	Sweep-mill outside of body	Lincoln type mill. mach.	Spec. rotary fixt. holds two pieces	75	0.010	30	2
7	Sweep-mill rear end of body	Lincoln type mill. mach.	Spec. rotary fixt. holds two pieces	75	0.010	30	2
8	Mill sight leaf hinge lugs and sides	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.015	45	2
9	Profile clearance cut for sight leaf spring groove, rough	One-spindle profiling mach.	Spec. fixt.	75	Hand	25	1
10	Shave clearance cut for sight leaf	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	25	1
11	Profile sight leaf spring groove, finish	Single-spindle profiling mach.	Spec. fixt.	75	Hand	30	1
12	Mill sight leaf retaining slots	Hand mill. machine	Spec. fixt.	80	Hand	40	1
13	Drill and ream sight leaf pin hole	Two-spindle drill. mach.	Spec. jig	30-75	Hand	85	1
14	File and burr	......	Files	..	..	35	1
15	Stamp	......	Hand stamps	..	..	250	1
16	Polish	Polishing lathe	Leather covered wheels	4500	Hand	35	1
17	Blue	Niter bath	......	See text	..	..	..

shoulder, enabling two depths of milling cuts to be made.

Operation 10: Shave Clearance Cut for Sight Leaf.—This operation is accomplished in a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work.

Operation 11: Profile Sight Leaf Spring Groove, Finish.—This operation is performed on a single-spindle profiling machine.

Operation 12: Mill Sight Leaf Retaining Slots.—This operation is accomplished in a hand milling machine, using a special fixture for holding the work. The milling is done with a T-shaped cutter.

Operation 13: Drill and Ream Sight Leaf Pin Hole.—This is accomplished in a two-spindle sensitive drilling machine, the work being held in a special jig so that the drilling can be accomplished from one side and the reaming from the other.

Operation 14: File and Burr.—This is a hand operation.

Operation 15: Stamp.—This operation consists in stamping the part number on the work by hand stamps.

Operation 16: Polish.—See "Polish."

Operation 17: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON REAR SIGHT LEAF

The rear sight leaf (see Fig. 32) is made from a rectangular bar of cold-rolled gun steel, 1/2 by 15/16 inch. The first operation, which is cutting these strips into pieces of the desired length, can be accomplished either in a punch press or in a cutting-off machine. In this case a punch press is specified. The following operations consist in grinding the right- and left-hand edges, which is done on a Blanchard vertical surface grinder. These finish-ground surfaces act as locating points

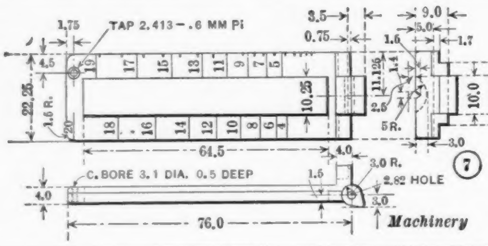
for the subsequent milling operations. For additional details, such as feeds, speeds and production, see Table IX.

Operation 1: Cut Off to Length.—This operation is accomplished in a punch press, using a shearing punch and die.

Operation 2: Grind Right- and Left-hand Edges.—This is done in a Blanchard vertical surface grinder by holding the work on a magnetic chuck. About eighty pieces are held on the chuck at one time, and the grinding is done with a silicate, corundum wheel, grain 30, grade ¾, 16 inches in diameter by 1½ inch rim. The table speed is roughing, 17 R. P. M.; finishing, 5 R. P. M. The down feed of the wheel is 0.0012 inch per revolution of the table, and from 0.010 to 0.015 inch is ground from each side.

Operation 3: Mill Top Face, Ends and Sight Lug, Rough.—This operation is accomplished in a Lincoln type milling machine, using special vise jaws that hold two pieces.

TABLE IX. OPERATIONS ON REAR SIGHT LEAF—PART NO. 7



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to length	Punch press	Shearing punch and die	60 st'k's	Hand	40	1
2	Grind right- and left-hand edges	Blanchard surf. grinder	Magnetic chuck	See text		225	1
3	Mill top face, ends and sight lug, rough	Lincoln type mill. mach.	Spec. vise jaws	70	0.020	50	2
4	Mill bottom face and ends, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	50	2
5	Mill top face, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	40	2
6	Mill joint cut on lower end	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	45	2
7	Mill spring and sighting opening	Hand mill. mach.	Spec. fixt. holds one piece	70	Hand	30	1
8	Shave spring and sighting opening	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	0.002 per stroke	20	1
9	Shave spring angle on lower end	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	0.002 per stroke	40	1
10	Drill and ream joint pin hole and drill stop screw hole	3-spindle sensitive drill. mach.	Spec. jig	D., 75 R. 30	0.003 0.010	35	1
11	Tap stop screw hole	Bench tapping mach.	Spec. fixt.	20	..	100	1
12	Mill clearance cut for sight	Hand milling mach.	Spec. fixture and tool	80	Hand	50	1
13	Mill sight notch	Hand milling mach.	Spec. fixture	80	Hand	100	1
14	Mill notches in right-hand side	Hand mill. mach.	Spec. fixt.	70	0.005	35	1
15	Mill graduations in left-hand side	Hand milling mach.	Spec. fixture gang cutters	75	Hand	45	1
16	Mill graduations in right-hand side	Hand milling mach.	Spec. fixt. gang cutters	75	Hand	45	1
17	Engrave figures	Gorton No. 1A engraving machine	Spec. fixture	125	Hand	15	1
18	File corners and burr	...	Files	..	..	25	1
19	Polish	Polishing lathe	Leather covered wheels	4500	..	60	1
20	Blue	Niter bath	...	..	..	See text	

Operation 4: Mill Bottom Face and Ends, Rough.—This is accomplished on a Lincoln type milling machine, using a special fixture fitted up with vise jaws for holding two pieces at one setting. One side of the fixture is made adjustable.

Operation 5: Mill Top Face, Finish.—This operation is accomplished in a similar manner to Operation 4, a special fixture with one adjustable side being used.

Operation 6: Mill Joint Cut on Lower End.—This is done in a Lincoln type milling machine, using a special fixture with jaws that hold two pieces. The hinge joint is straddle-milled.

Operation 7: Mill Spring and Sighting Opening.—This operation is accomplished in a hand milling machine provided with a fixture that has special jaws holding one piece. An end-milling cutter is used for making the cut, and a former on the fixture controls its movement.

Operation 8: Shave Spring and Sighting Opening.—This operation is accomplished in a Pratt & Whitney vertical bench shaving machine provided with a special fixture for holding one piece.

Operation 9: Shave Spring Angle on Lower End.—This is accomplished in a similar manner to Operation 8.

Operation 10: Drill and Ream Joint Pin Hole and Drill Stop Screw Hole.—These operations are accomplished on a three-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 11: Tap Stop Screw Hole.—This is done in a bench tapping machine, using a simple jig.

Operation 12: Mill Clearance Cut for Sight.—This operation is accomplished in a hand milling machine, using a fixture provided with special vise jaws, holding one piece. An end-milling cutter is used to take the cut.

Operation 13: Mill Sight Notch.—This is done in a hand milling machine, using special jaws for holding the work.

Operation 14: Mill Notches in Right-hand Side.—This operation is accomplished in a hand milling machine, using special jaws for holding one piece and a gang of slitting cutters on the arbor.

Operation 15: Mill Graduations in Left-hand Side.—This operation is accomplished in a hand milling machine, in a similar manner to Operation 14, with the exception that the work is held with the flat instead of the edge up.

Operation 16: Mill Graduations in Right-hand Side.—This operation is similar to Operation 15.

Operation 17: Engrave Figures.—This is accomplished in a Gorton No. 1A engraving machine, using a special fixture for holding the work.

Operation 18: File Corners and Burr.—This is a hand operation.

Operation 19: Polish.—See "Polish."

Operation 20: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON REAR SIGHT LEAF SPRING

The rear sight leaf spring is made from a hot-rolled ½ by ⅜ inch bar of vanadium type D steel. (See Fig. 32.) The first operation is cutting off to approximate length in a punch press with a shearing punch and die. The next operation is to grind the right- and left-hand sides to bring the piece to the required width. The piece is then milled to shape, using the previously ground sides as locating points. See Table X for feeds, etc.

Operation 1: Cut Off to Length.—This operation is accomplished in a punch press, using a shearing punch and die, the press operating at 60 strokes per minute. A stop in the die controls the length of the piece.

Operation 2: Grind Right-hand Side.—This operation is done on a Blanchard vertical surface grinder, holding 150 pieces on the chuck inside of a retaining ring. The wheel used for this purpose is 16 inches in diameter, rotating at 4190 surface feet per minute, 1½ inch rim, grain 58-24, grade 1, corundum, silicate. The down feed of the cutter-head is 0.0012 inch per revolution of the table. The table speeds are 17 R. P. M., roughing; 5 R. P. M. finishing.

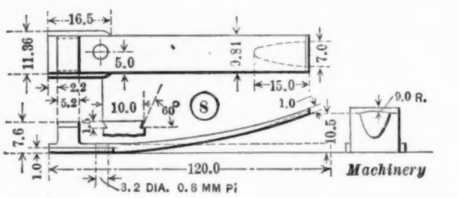
Operation 3: Grind Left-hand Side.—This operation is accomplished in a similar manner to Operation 2.

Operation 4: Mill Bottom and Face Ends to Length.—This is accomplished in a Lincoln type milling machine with a quick-acting vise provided with special jaws in which two pieces are held side by side. High-speed steel milling cutters are used.

Operation 5: Mill Top Faces and Sides of Boss, Rough.—This operation is performed in a Lincoln type milling machine carrying a quick-acting vise provided with special jaws that hold two pieces. This cut leaves about 1/32 to 3/64 inch to be removed by the finishing cut.

Operation 6: Mill Top Faces and Sides of Boss, Finish.—This operation is similar to Operation 5, with the exception that the cutter for the top of the spring is made to cut the desired angle on the top.

TABLE X. OPERATIONS ON REAR SIGHT LEAF SPRING—PART NO. 8



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to length	Punch press	Shearing punch and die	60 st'k's	Hand	1200	1
2	Grind right-hand side	Blanchard surf. grinder	Mag. chuck	See text		500	1
3	Grind left-hand side	Blanchard surf. grinder	Mag. chuck	See text		500	1
4	Mill bottom and face ends to length	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	50	0.020	50	2
5	Mill top faces and sides of boss, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	50	0.015	48	2
6	Mill top faces and sides of boss, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	55	0.010	40	2
7	Straddle-mill sides of boss	Hand mill. mach.	Spec. vise jaws	55	0.010	40	1
8	Mill dovetail slots in right- and left-hand sides of boss	Hand mill. mach.	Spec. index. fixt.	55	Hand	30	1
9	Mill clearance cut on right-hand side of tang	Hand mill. mach.	Spec. vise jaws	55	Hand	50	1
10	Mill clearance cut on left-hand side of tang	Hand mill. mach.	Spec. vise jaws	55	Hand	50	1
11	Mill clearance cut in lower face of tang	Hand mill. mach.	Spec. vise jaws	50	Hand	50	1
12	Drill and countersink screw hole	One-spin. drill. mach.	Spec. jig comb. drill and c. s.	60	Hand	300	1
13	Tap screw hole	Tapping mach.	Spec. jig	20	Hand	250	1
14	Bend to shape	Punch press	Bend. punch and die	60 st'k's	Hand	200	1
15	Stamp	......	Hand stamp	..	..	250	1
16	File and burr	......	Files	..	..	50	1
17	Polish	Polishing lathe	Leather covered wheels	4500	..	65	1
18	Harden and temper	Hard. furn. tempering bath	......	..	..	150	1

Operation 7: Straddle-mill Sides of Boss.—This operation is accomplished in a hand milling machine, one piece being held at a time in special vise jaws.

Operation 8: Mill Dovetail Slots in Right- and Left-hand Sides of Boss.—This operation is accomplished in a hand milling machine provided with an index milling fixture.

Operation 9: Mill Clearance Cut on Right-hand Side of Tang.—This is accomplished in a hand milling machine, using special vise jaws for holding the work.

Operation 10: Mill Clearance Cut on Left-hand Side of Tang.—This is similar to Operation 9.

Operation 11: Mill Clearance Cut in Lower Face of Tang.—This operation is accomplished in a hand milling machine, using special vise jaws that hold the work at the required angle.

Operation 12: Drill and Countersink Screw Hole.—This is done in a one-spindle drilling machine, holding the work in a simple jig and using a combination drill and countersink.

Operation 13: Tap Screw Hole.—This operation is accomplished in a one-spindle tapping machine.

Operation 14: Bend to Shape.—This operation is accomplished in a punch press, using a bending punch and die.

Operation 15: Stamp.—This consists in stamping the number on the part.

Operation 16: File and Burr.—This is a hand operation.

Operation 17: Polish.—See "Polish."

Operation 18: Harden and Temper.—See "Harden" and "Temper."

OPERATIONS ON REAR SIGHT SLIDE

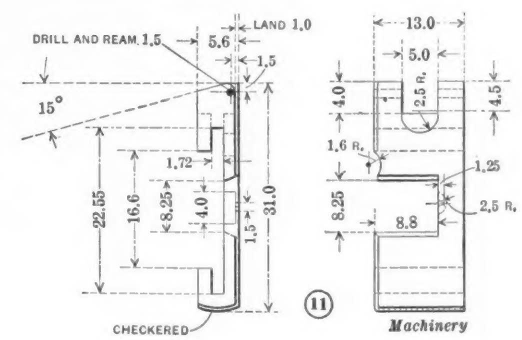
The rear sight slide is made from a 1 3/8 by 5/16 inch bar of hot-drawn gun steel (see Fig. 32), which is cut up into lengths of 3 inches, sufficient to make five pieces. The next operation consists in milling one edge to facilitate clamping, after which the large slot and bottom surface are rough-milled. In the subsequent operations, the slot and the lower edge act as locating points for performing the various milling operations. On some of the operations, however, the bottom surface, one edge, and one end are used as locating and gaging points.

Operation 1: Cut Off into 3-inch Lengths.—This operation is performed in a punch press, using a shearing punch and die.

Operation 2: Mill One Edge.—This is accomplished in a Lincoln type milling machine, using special vise jaws that hold six pieces in group formation.

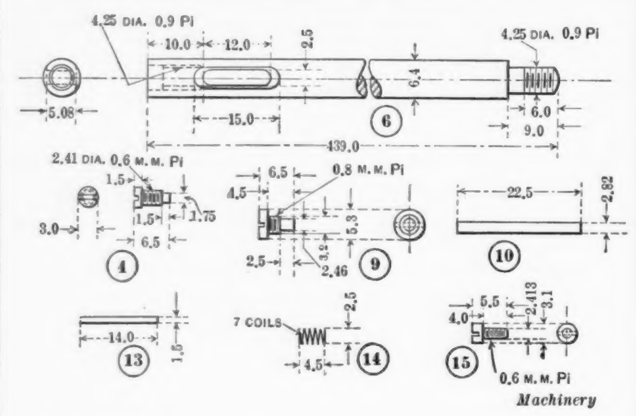
Operation 3: Mill Bottom Surface and Slot, Rough.—This operation is done in a Lincoln type milling machine, using a special vise that holds two pieces. This vise is designed with two adjustable clamping jaws and one center stationary jaw.

TABLE XI. OPERATIONS ON REAR SIGHT SLIDE—PART NO. 11



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off into 3-inch lengths	Punch press	Shearing punch and die	60 st'k's	Hand	2500	1
2	Mill one edge	Lincoln type mill. mach.	Vise jaws; hold six pieces	70	0.020	1000	2
3	Mill bottom surf. and slot, rough	Lincoln type mill. mach.	Spec. vise; holds two pieces	70	0.015	150	3
4	Grind top surface	Blanchard surf. grinder	Magnetic chuck	See text		700	1
5	Cut off to length	Lincoln type mill. mach.	Spec. vise; holds two pieces	70	0.020	200	2
6	Mill bottom edge	Lincoln type mill. mach.	Vise jaws; hold six pieces	70	0.020	150	2
7	Mill bottom surf. and slot, finish	Lincoln type mill. mach.	Spec. vise; holds two pieces	70	0.015	35	2
8	Mill T-slot, finish	Hand mill. mach.	Spec. vise jaws; hold one piece	75	Hand	40	1
9	Mill hinge slot and right-hand end	Hand mill. mach.	Spec. vise jaws; hold two pieces	70	Hand	100	1
10	Mill seat for slide catch	Hand mill. mach.	Spec. vise jaws; hold one piece	75	Hand	60	1
11	Mill large sight slot and top edge	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	70	0.015	40	2
12	Mill bevel edges on left- and right-hand sides of large slot	Hand mill. mach.	Index. fixt.	70	Hand	50	1
13	Mill sight notch	Hand mill. mach.	Spec. vise jaws; hold one piece	70	Hand	100	1
14	Mill clearance for sight notch	Hand mill. mach.	Spec. vise jaws; hold one piece	75	Hand	75	1
15	Mill angular clearance on right-hand side	Hand mill. mach.	Spec. vise jaws; hold one piece	70	Hand	60	1
16	Mill radius on top front edge	Hand mill. mach.	Spec. vise jaws; hold one piece	70	Hand	60	1
17	Mill serrations on left-hand end, first setting	Hand mill. mach.	Spec. vise jaws; spec. hob	70	Hand	50	1
18	Mill serrations on left-hand end, second setting	Hand mill. mach.	Spec. rotary fixt.; spec. hob	70	Hand	50	1
19	Drill and ream pin hole	Two-spindle drill. mach.	Drill jig	30-60	Hand	60	1
20	Stamp	......	Hand stamps	..	..	250	1
21	File and burr	......	Files	..	..	60	1
22	Polish	Polishing lathe	Leather cov. wheels	5000	Hand	45	1
23	Blue	Niter bath	......	See text		..	..

TABLE XII. OPERATIONS ON MISCELLANEOUS SIGHT PARTS AND CLEANING ROD



Part No.	Operation	Machine Used	Hourly Product per Mach.	Machs. per Operator
4	Form thread cut off and slot	Aut. screw mach. with slotting attachment	270	3
4	Polish	Polishing lathe, leather covered wheels	500	1
4	Blue	See text	...	...
6	Cut off to length	Punch press	1200	1
6	Form and thread	Hand screw machine	45	1
6	Face, counterbore, drill and tap	Hand screw machine	40	1
6	Mill flat on sides	Hand mill. mach. index fixture	45	1
6	Spline mill slot	P. & W. spline mill. mach.	30	2
9	Form, thread cut off and slot	Aut. screw mach. with slotting attachment	270	3
10	Form, cut off and burr	Auto. form. mach. with burring attach.	400	3
10	Harden and temper	Harden and temp. bath	250	1
13	Form, cut off and burr	Auto. form. mach. with burring attach.	1000	3
13	Harden and temper	Harden and temp. bath	500	1
14	Wind, set and cut off	No. 1 spring coiling mach.	6000	2
14	Spring temper	Tempering bath	500	1
15	Form, thread cut off and slot	Auto. screw mach. with Slotting attachment	320	3
15	Polish	Polishing lathe, leather covered wheels	500	1
15	Blue	See text	...	...

Operation 4: Grind Top Surface.—This is accomplished on a Blanchard vertical surface grinder by holding eighty pieces on the magnetic chuck inside of a retaining ring. The wheel used is 16 inches diameter, $1\frac{1}{2}$ inch rim, and runs at 4190 surface feet per minute. The wheel used is corundum, silicate, grain 24, grade 1. The depth of cut is 0.0012 inch per revolution of the work-table. The speed of the work-table is 13 R. P. M., roughing; 5 R. P. M., finishing.

Operation 5: Cut Off to Length.—This operation is performed on a Lincoln type milling machine, using special vise jaws that hold two pieces. Four saws 1/16 inch wide are used to cut off these pieces, and at the same time two milling cutters at each end face off the rough ends of the bars. The jaws are slotted to clear the saws.

Operation 6: Mill Bottom Edge.—This operation is accomplished in a Lincoln type milling machine, using vise jaws that hold six pieces. The bottom edge is milled to act as a locating point in subsequent operations.

Operation 7: Mill Bottom Surface and Slot, Finish.—This is accomplished in a Lincoln type milling machine, using the same type of vise as for Operation 3. The work is held by the sides instead of from the ends, so as not to spring it.

Operation 8: Mill T-slot, Finish.—This operation is accomplished in a hand milling machine, using a T-cutter. Special vise jaws are provided for holding the piece.

Operation 9: Mill Hinge Slot and Right-hand End.—This is done in a hand milling machine, using special vise jaws that hold two pieces.

Operation 10: Mill Seat for Slide Catch.—This operation is accomplished in a hand milling machine, using special vise jaws and an end-milling cutter.

Operation 11: Mill Large Sight Slot and Top Edge.—This is accomplished in a Lincoln type milling machine, using special vise jaws that hold two pieces.

Operation 12: Mill Bevel Edges on Left- and Right-hand Sides of Large Slot.—This operation is accomplished in a hand milling machine, using a side milling cutter and a special indexing fixture for indexing the piece in position for milling both edges.

Operation 13: Mill Sight Notch.—This is done in a hand milling machine, using a bevel cutter and special vise jaws.

Operation 14: Mill Clearance for Sight Notch.—This operation is accomplished in a hand milling machine, using an end-milling cutter and special vise jaws.

Operation 15: Mill Angular Clearance on Right-hand Side.—This operation is accomplished in a hand milling machine, using special vise jaws.

Operation 16: Mill Radius on Top Front Edge.—This is accomplished in a hand milling machine, using a radius cutter.

Operation 17: Mill Serrations on Left-hand End, First Setting.—This operation is accomplished in a hand milling machine, using special vise jaws for holding the work and a formed hob.

Operation 18: Mill Serrations on Left-hand End, Second Setting.—This is done on a hand milling machine, using a special hob and a rotary fixture.

Operation 19: Drill and Ream Pin Hole.—This operation is accomplished on a two-spindle sensitive drilling machine.

Operation 20: Stamp.—This consists in stamping a number on the parts with hand stamps.

Operation 21: File and Burr.—In this operation all sharp corners and burrs are removed.

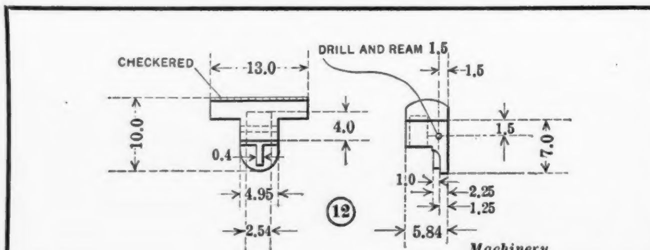
Operation 22: Polish.—See "Polish."

Operation 23: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON REAR SIGHT SLIDE CATCH

The rear sight slide catch (see Fig. 32) is made from hot-rolled gun steel, and the most satisfactory method is to shear off pieces $3\frac{3}{8}$ inches in length from $\frac{5}{8}$ by $\frac{1}{2}$ inch stock. These strips are then ground on the right- and left-hand edges on a Blanchard vertical surface grinder, held in special vise jaws, two at a time and milled, rough-forming the extended

TABLE XIII. OPERATIONS ON REAR SIGHT SLIDE CATCH—PART NO. 12



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off into $3\frac{3}{8}$-inch lengths	Punch press	Shearing punch and die	60 st'k's	Hand	1500	1
2	Grind right- and left-hand edges	Blanchard surf. grinder	Mag. chuck	See text		2500	1
3	Mill bottom surface	Lincoln type mill. mach.	Spec. vise jaws; hold four strips	60	0.020	800	2
4	Mill top surf. and lug, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	60	0.020	400	2
5	Mill locking step and cut off to length	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	60	0.015	500	1
6	Grind front and rear surfaces	Blanchard surf. grinder	Mag. chuck	See text		1000	1
7	Mill clearance radius	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
8	Mill locking step	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
9	Drill and c. bore spring hole and drill and ream pin hole	4-spindle drill. mach.	Spec. jig	30-60	Hand	45	1
10	Mill serrations—first setting	Hand mill. mach.	Spec. vise jaws. Spec. hob	70	Hand	50	1
11	Mill serrations—second setting	Hand mill. mach.	Spec. rotary fixt. Spec. hob	70	Hand	50	1
12	Stamp	......	Stamps	..	..	250	1
13	File and burr	......	Files	..	..	120	1
14	Polish	Polishing lathe	Leather covered wheels	5000	Hand	50	1
15	Blue	Niter bath	See text	..	..	..	..

Argentine Mauser—Modified German Mauser Bolt Action, Model 1896

piece. The previously ground surfaces act as locating and gaging points. For additional details, such as feeds, speeds and production, see Table XIII.

Operation 1: Cut Off into 3⅜-inch Lengths.—This operation is accomplished on a punch press, using a shearing punch and die.

Operation 2: Grind Right- and Left-hand Edges.—This operation is accomplished on a Blanchard vertical surface grinder, on which about eighty strips are held on the magnetic chuck inside of a retaining ring. 0.010 to 0.015 inch of material is ground from each surface, and the limits are $\pm$ 0.002 inch. The wheel used is 16-inch diameter, 1½-inch face, grain 30, grade ¾, silicate, corundum. The wheel speed is 4190 surface feet per minute. The table feed is 17 R. P. M., roughing; 5 R. P. M. finishing. The depth of cut per revolution is 0.0012 inch.

Operation 3: Mill Bottom Surface.—This is done on a Lincoln type milling machine, using special vise jaws that hold four strips. A high-speed steel serrated milling cutter is used.

Operation 4: Mill Top Surface and Lug, Rough.—This operation is accomplished on a Lincoln type milling machine, provided with a special pair of vise jaws that hold two strips. Three milling cutters of the interlocking type are used.

Operation 5: Mill Locking Step and Cut Off to Length.—This operation is performed on a Lincoln type milling machine, using special vise jaws that hold two strips, and saws and cutters equally spaced along the arbor. In this operation the milled strips are cut up into ten pieces each.

Operation 6: Grind Front and Rear Surfaces.—This operation is accomplished on a Blanchard vertical surface grinder, and is similar to Operation 2, except that 500 pieces are held on the magnetic chuck at one time.

Operation 7: Mill Clearance Radius.—This operation is done on a hand milling machine of the Whitney type, using straddle-milling cutters, the cutter being dropped down onto the work to form the radius. A special pair of vise jaws is used, holding one piece.

Operation 8: Mill Locking Step.—This operation is accomplished on a hand milling machine, using special vise jaws and a special formed straddle-milling cutter.

Operation 9: Drill and Counterbore Spring Hole, and Drill and Ream Pin Hole.—These operations are accomplished on a four-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 10: Mill Serrations—First Setting.—This is done on a hand milling machine, using a hob type of cutter and special vise jaws for holding the piece.

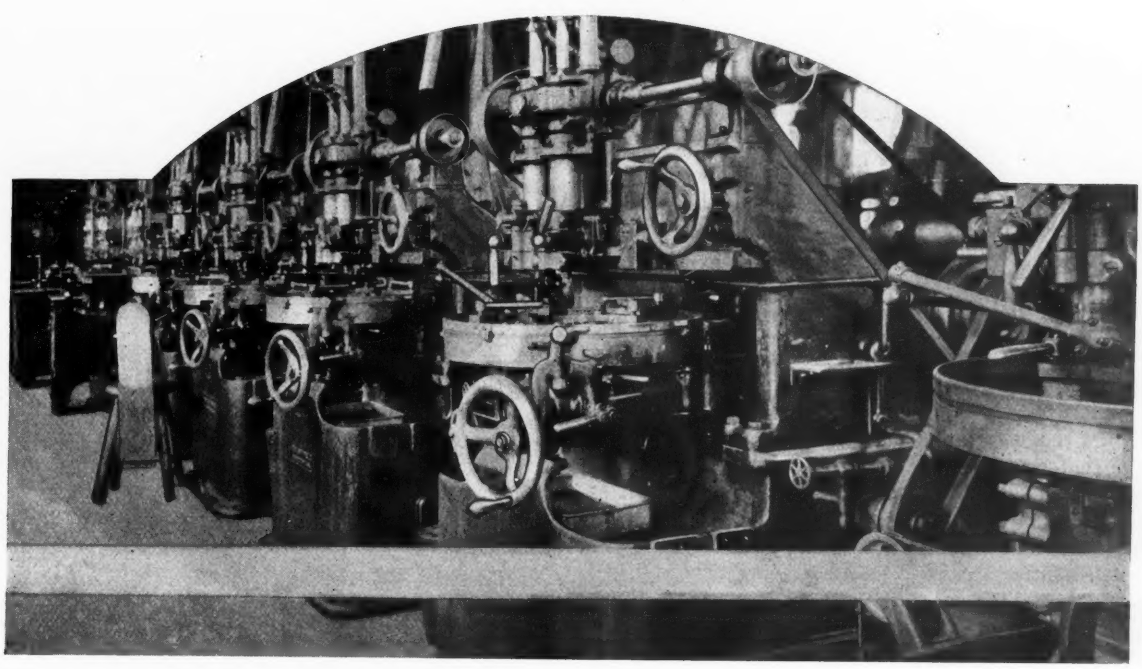
Operation 11: Mill Serrations—Second Setting.—This operation is accomplished on a hand milling machine, using a special rotary fixture and a special hob.

Operation 12: Stamp.—This is a hand operation.

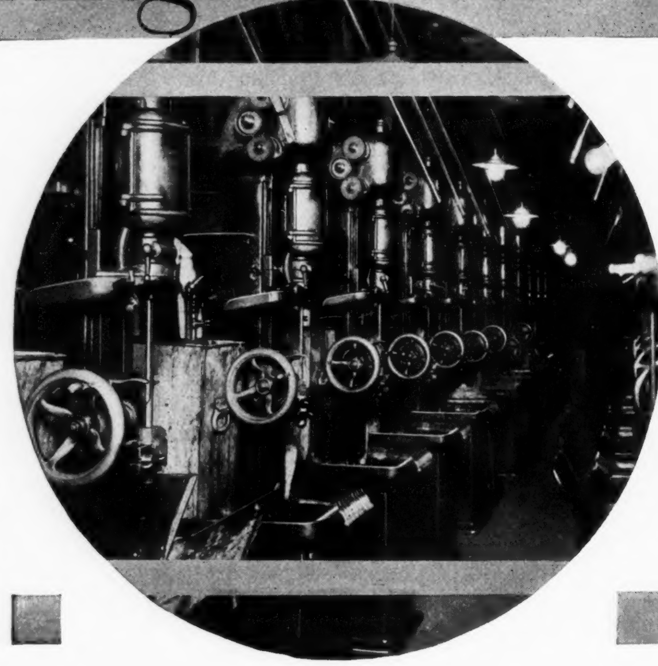
Operation 13: File and Burr.—This is also a hand operation.

Operation 14: Polish.—See "Polish."

Operation 15: Blue.—See "Blue—Niter Bath Process."



Machining Receiver and Parts



THE receiver, which must be capable of withstanding severe shocks and also have a hard surface to resist wear, is made from a special carbon steel known as C steel. This material, when properly annealed, machines easily. The board type of drop-hammer has been recommended for forging in this article because it has been practically universally used in forging rifle parts. Of late, however, the steam type of drop-hammer has come into use and has proved to be superior in many respects to the board type of drop-hammer. The chief advantage of the steam drop-hammer is that it can be operated much more rapidly. The first operation on the receiver is drop-forging and trimming, and after annealing and pickling, the part is ready for machining. Owing to the importance of this part, great care must be exercised in the selection of locating and clamping points. For the various operations, these points have been indicated on the operation sheet, Figs. 34 to 37. Wherever possible, however, the hole and front end of the receiver should be used for locating and gaging points. In some cases the bottom surface is also used, and this is indicated in the illustrations referred to. For additional information on feeds, speeds, and production, see Table XIV.

Operation 1: Drop-forge and Trim.—This operation is accomplished in a 1200-pound drop-hammer, one man attending to the furnace, trimming press, and drop-hammer.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Mill Bottom, Rough.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. High-speed steel milling cutters of the eccentrically relieved interlocking type are used.

Operation 4: Spot, Drill, Recess, Ream, Chamfer, and Face.—This is accomplished on a turret lathe, using a special chuck for holding the rough forgings and locating the work from the previously machined face.

Operation 5: Straddle-mill Both Sides.—This operation is accomplished on a Lincoln type milling machine, using high-speed steel eccentrically relieved milling cutters, and a special fixture that holds two pieces. The fixture is made with one side adjustable to compensate for wear of the cutters.

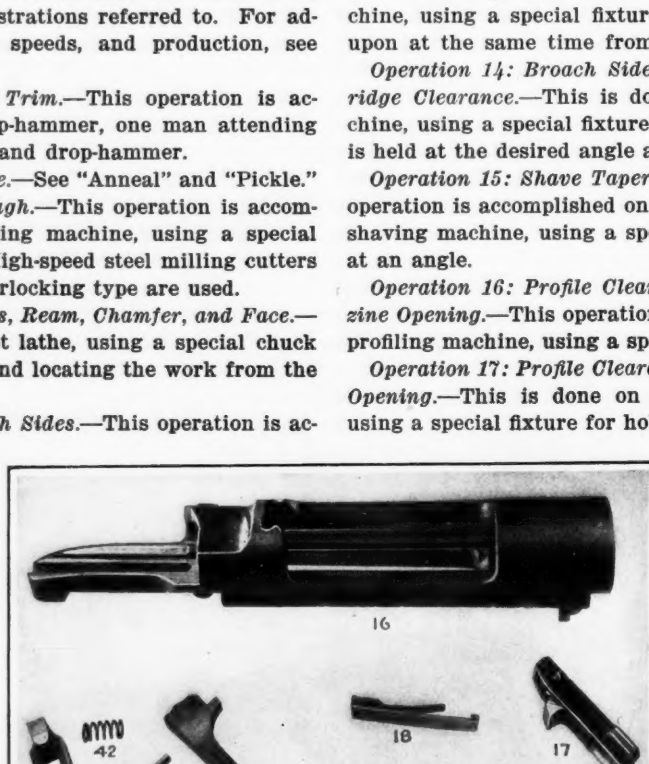


Fig. 33. Spanish Mauser Receiver, Retaining Bolt, Trigger and Sear Parts

Operation 6: Mill Bottom, Finish.—This is similar to Operation 3, but is handled in a different manner. In this case the work is located from the previously drilled and reamed center hole.

Operation 7: Sweep-mill Top.—This operation is accomplished on a Lincoln type milling machine, using a special type of rotary fixture, operated through a special gearing device.

Operation 8: Profile Top for Cartridge Ejector, Rough and Finish.—This is done on a two-spindle profiling machine, using a roughing and finishing former and a roughing and finishing cutter.

Operation 9: Sweep-mill Top at Rear End.—This operation is accomplished on a Lincoln type milling machine in a similar manner to Operation 7.

Operation 10: Mill Cartridge Clearance, Rough.—This is accomplished on a hand milling machine, using a special fixture for holding the work that locates it from the previously drilled and reamed hole.

Operation 11: Mill Radius on Left-hand Top Side.—This operation is performed on a hand milling machine, using a relieved cutter, formed to the desired radius.

Operation 12: Sweep-mill Bottom Circular Surfaces.—This is accomplished on a Lincoln type milling machine in a similar manner to Operation 7.

Operation 13: Spline-mill Magazine Opening.—This operation is accomplished on a Pratt & Whitney spline milling machine, using a special fixture that holds two pieces, operated upon at the same time from the two opposing spindles.

Operation 14: Broach Sides of Magazine Opening and Cartridge Clearance.—This is done on a Lapointe broaching machine, using a special fixture for holding the work. The work is held at the desired angle and one broach finishes the slot.

Operation 15: Shave Taper End of Magazine Opening.—This operation is accomplished on a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work at an angle.

Operation 16: Profile Clearance Cut in Front End of Magazine Opening.—This operation is accomplished on a one-spindle profiling machine, using a special fixture for holding the work.

Operation 17: Profile Clearance Cut in Rear End of Magazine Opening.—This is done on a one-spindle profiling machine, using a special fixture for holding the work.

Operation 18: Profile Magazine Platform Stop Pocket, Rough and Finish.—This operation is accomplished on a two-spindle profiling machine, using a tapered cutter and roughing and finishing former guides.

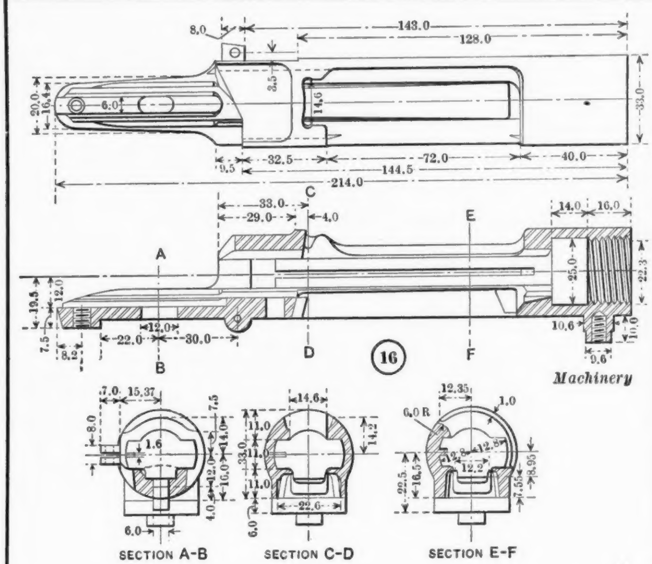
Operation 19: Profile Clearance Cuts in Rear End of Cartridge Opening.—This is accomplished on a one-spindle profiling machine, using a tapered cutter, and the work is set at an angle in a special fixture.

Operation 20: Shave Clearance Cuts in Rear End and

Sides of Cartridge Opening.—This operation is accomplished on a Pratt & Whitney vertical bench shaving machine.

Operation 21: Mill Top Surface of Tang.—This is done on

TABLE XIV. OPERATIONS ON RECEIVER—PART NO. 16



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	1200-lb. drop-hammer	Forging dies trim. punch and die	..	..	40	1
2	Anneal and pickle	Annealing furnace pickling bath	......	..	..	25	See text
3	Mill bottom, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.062	40	2
4	Spot, drill, recess, ream, chamfer and face	Turret lathe	Spec. chuck	30-60	0.010-0.040	10	1
5	Straddle-mill both sides	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.062	30	3
6	Mill bottom, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.040	40	2
7	Sweep-mill top	Lincoln type mill. mach.	Spec. rotary fixt.	50	0.032	20	2
8	Profile top for cartridge ejector, rough and finish	Two-spindle profiling mach.	Spec. fixt.	70	Hand	15	1
9	Sweep-mill top at rear end	Lincoln type mill. mach.	Spec. rotary fixt.	50	0.032	20	2
10	Mill cartridge clearance, rough	Hand mill. mach.	Spec. fixt.	70	Hand	30	1
11	Mill radius on left-hand top side	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
12	Sweep-mill bottom circular surfaces	Lincoln type mill. mach.	Spec. rotary fixt.	50	0.032	25	2
13	Spline-mill magazine opening	P. & W. spline mill. mach.	Spec. fixt. holds two pieces	70	0.010	12	4
14	Broach sides of magazine opening and cartridge clearance	Lapointe broaching mach.	Spec. fixt. broach	..	..	30	1
15	Shave taper end of magazine opening	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	45	1
16	Profile clearance cut in front end of magazine opening	One-spindle profiling mach.	Spec. fixt.	70	Hand	60	1
17	Profile clearance cut in rear end of magazine opening	One-spindle profiling mach.	Spec. fixt.	70	Hand	60	1
18	Profile magazine platform stop pocket, rough and finish	Two-spindle profiling mach.	Spec. fixt.	70	Hand	30	1
19	Profile clearance cuts in rear end of cartridge opening	One-spindle profiling mach.	Spec. fixt.	70	Hand	60	1
20	Shave clearance cuts in rear end and sides of cartridge opening	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	45	1
21	Mill top surface of tang	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.032	45	2
22	Mill bolt slide clearance in tang, rough and finish	No. 1 Rockford radial drill. mach.	Spec. fixt. two cutters	60	0.015-0.020	35	2
23	Profile outline on tang, rough and finish	Two-spindle profiling mach.	Spec. fixt.	70	Hand	35	1
24	Profile extractor cam surface, rough	One-spindle profiling mach.	Spec. fixt.	70	Hand	40	1
25	Mill extractor cam surface and bolt lever clearance, finish	One-spindle profiling mach.	Spec. rotary fixt.	65	Hand	30	1
26	Mill cocking-piece clearance slot in tang	Hand mill. mach.	Spec. fixt.	70	Hand	20	1
27	Mill clearance for extractor slot in front end	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
28	Shave guide slot for bolt head	P. &. W. horiz. splining mach.	Spec. fixt's hold two pieces Spec. cutter-bars	30	0.002	30	2
29	Shave right side of bolt lug slot	P. & W. horiz. splining mach.	Spec. fixt's. hold two pieces Spec. cutter-bars	30	0.002	20	2
30	Shave left side of bolt lug slot	P. & W. horiz. splining mach.	Spec. fixt's. hold two pieces Spec. cutter-bars	30	0.002	20	2
31	Mill cartridge clearance, finish	Hand mill. mach.	Spec. fixt.	70	Hand	35	1
32	Mill lower cartridge entrance	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
33	Mill upper cartridge entrance	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
34	Cut bolt locking cam lugs	Engine lathe	Spec. relieving device	..	..	20	2
35	Mill thread for barrel	Thread mill. mach.	Spec. fixt. Spec. hob	60	..	35	2
36	Hand tap thread for barrel	Spec. hand tap. mach.	Tapping fixt. and tap	Hand	Hand	35	1
37	Straddle-mill retaining bolt lug	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.040	35	2
38	Mill top and bottom of retaining bolt lug	Hand mill. mach.	Spec. fixt.	60	Hand	45	1
39	Drill, ream, and counterbore sear pin hole and retaining bolt stop hole	Four-spindle drill. mach.	Spec. jig	35-60	Hand	45	1
40	Mill slot for retaining bolt finger	Hand mill. mach.	Spec. fixt.	60	Hand	40	1
41	Shave opening for retaining bolt finger	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	45	1
42	Mill off and bevel bolt guide rib	Knee type plain mill. mach.	Spec. fixt.	50	0.020	30	1
43	Hollow-mill front guard screw boss	Upright drill. mach.	Spec. jig	30	Hand	50	1
44	Drill and counterbore guard screw holes, and drill hole for front sear tooth	Five-spindle drill. mach.	Spec. jig	35-60	Hand	35	1
45	Spline mill elongated sear opening in tang	P. & W. spline mill. mach.	Spec. fixt. holds two pieces	70	0.005	60	2
46	Profile lightening cut on front base end	One-spindle profiling mach.	Spec. fixt.	70	Hand	40	1
47	Mill remainder of bottom circular surface on tang	Hand mill. mach.	Spec. rotary fixt.	65	Hand	40	1
48	Mill chamfer on top rear end of chamber	Hand mill. mach.	Spec. rotary fixt.	70	Hand	60	1
49	Tap guard screw holes	Single-spindle drill. mach.	Tap attach.	25	Hand	45	1
50	Roll inscriptions on side	N. & W. marking mach.	Spec. fixt. Spec. roll	..	Hand	50	1
51	Stamp	......	Hand stamps	..	..	250	1
52	File and burr	......	Files	..	..	20	1
53	Pack-harden	Heating furnace	Oil bath tanks	..	..	25	1
54	Polish	Polishing lathe	Leather covered wheels	5000	..	6-8	1
55	Blue	American "bluing" gas furnace	Spec. racks	..	..	120 6 m'chs.	6

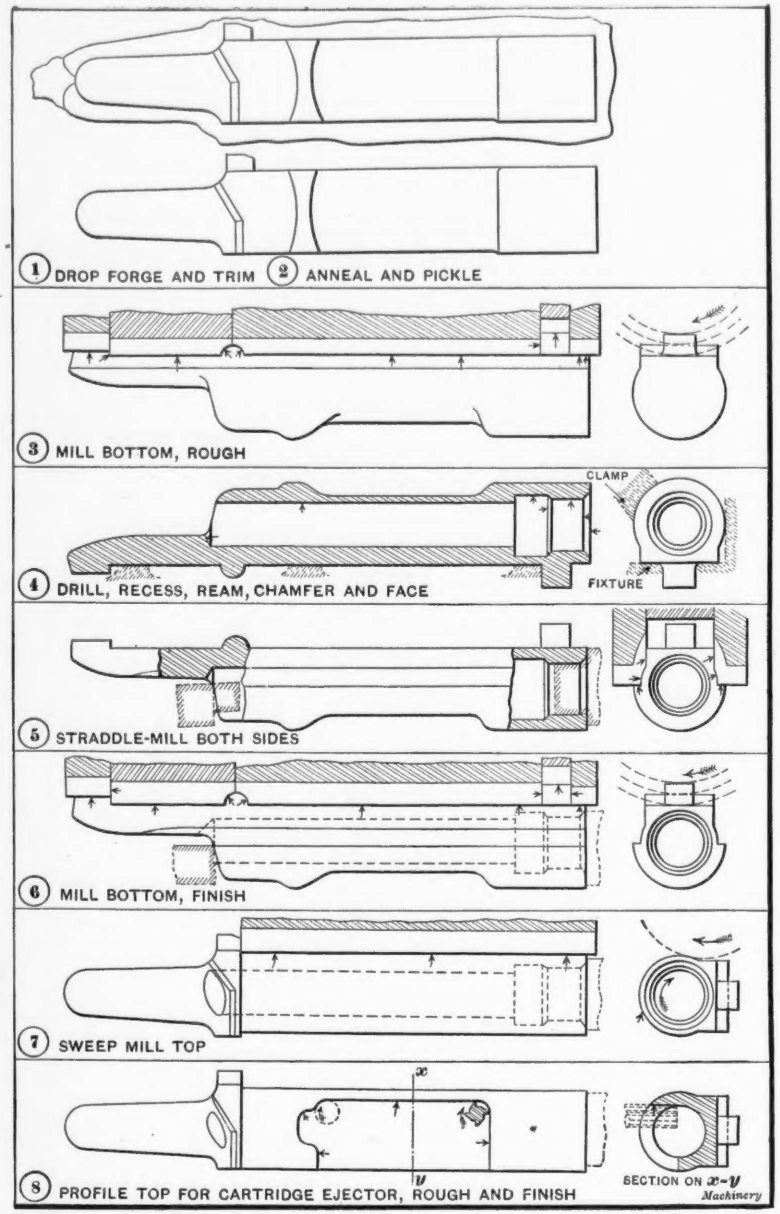


Fig. 34. Machining Operations on Spanish Mauser Receiver

a Lincoln type milling machine, using a special fixture that holds two pieces, and eccentrically relieved high-speed steel milling cutters. One side of the fixture is adjustable for height to compensate for variation in the diameters of the two sets of cutters.

Operation 22: Mill Bolt Slide Clearance in Tang, Rough and Finish.—This operation is accomplished on a No. 1 Rockford radial drilling machine, using a special fixture for holding the work. A roughing and a finishing cutter are used. These cutters are provided with pilots and are fed in from the end, being supported by a bushing in the fixture.

Operation 23: Profile Outline on Tang, Rough and Finish.—This operation is performed on a two-spindle profiling machine, using roughing and finishing guide forming blocks and taper milling cutters. The work is held at a slight angle so that the end is at right angles to the bottom surface of the receiver and the sides are milled in an angular position.

Operation 24: Profile Extractor Cam Surface, Rough.—This operation is accomplished on a one-spindle profiling machine, using a special fixture for holding the work.

Operation 25: Mill Extractor Cam Surface and Bolt Lever Clearance, Finish.—This is done on a single-spindle profiling machine, using a special rotary fixture that guides the cutter in a cam path.

Operation 26: Mill Cocking-piece Clearance Slot in Tang.—This operation is accomplished on a hand milling machine, using a special fixture for holding the work.

Operation 27: Mill Clearance for Extractor Slot in Front End.—This is accomplished on a hand milling machine, using a T-type of milling cutter and a special fixture for holding the work. The cutter is dropped down to the required depth.

Operation 28: Shave Guide Slot for Bolt Head.—This operation is performed on a Pratt & Whitney horizontal splining machine, of the double head type, using a special fixture for holding the work, and special cutter-bars designed on the principle of the hook type of rifling tool. In this machine, the work is held in fixtures fastened to a table that is traversed back

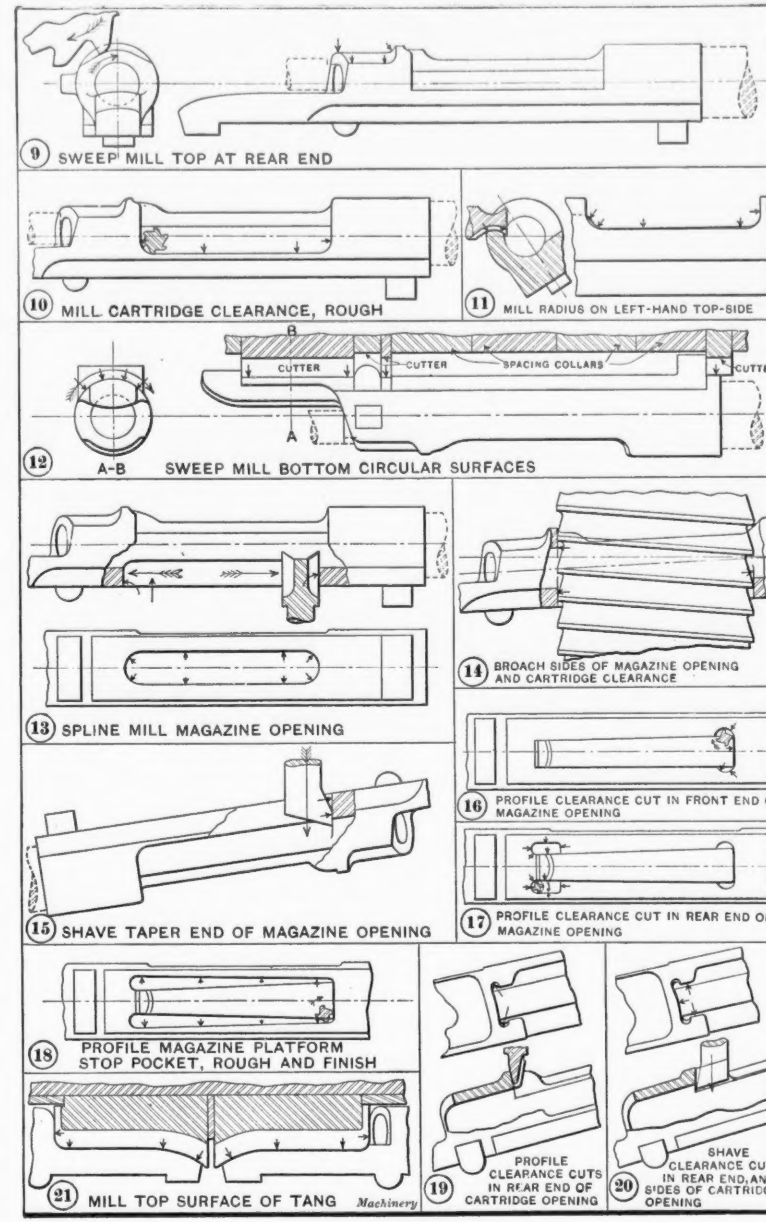


Fig. 35. Machining Operations on Spanish Mauser Receiver (Continued)

and forth, and two pieces of work are held on the table at one time so that a cut is taken at each traverse. The hook type of cutter is fed in the same way as in the Pratt & Whitney rifling machine.

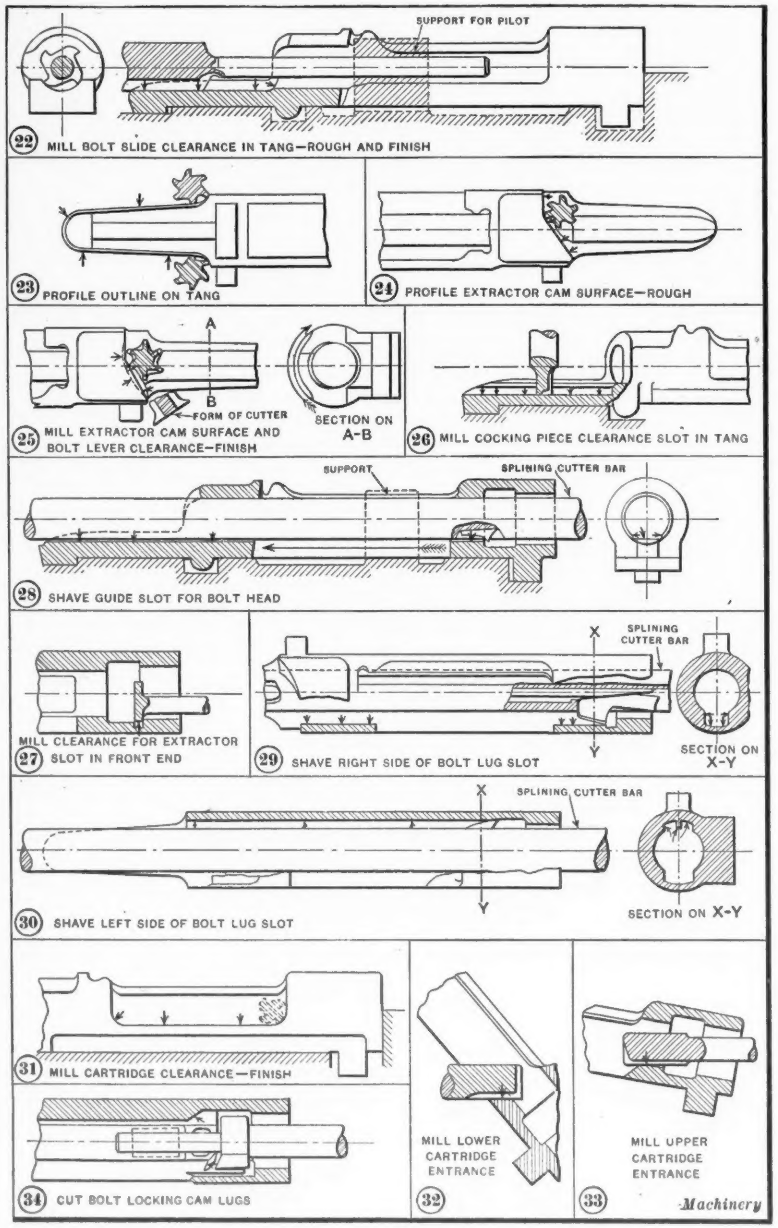


Fig. 36. Machining Operations on Spanish Mauser Receiver (Continued)

Operation 29: Shave Right Side of Bolt Lug Slot.—This operation is accomplished on a Pratt & Whitney horizontal splining machine, using a special fixture and special cutters as in the case of Operation 28.

Operation 30: Shave Left Side of Bolt Lug Slot.—This is done on a Pratt & Whitney horizontal spline milling machine in a similar manner to Operation 28.

Operation 31: Mill Cartridge Clearance, Finish.—This operation is accomplished on a hand milling machine, using an end-milling cutter, the work being held in a special fixture.

Operation 32: Mill Lower Cartridge Entrance.—This is accomplished on a hand milling machine, using a special fixture for holding the work at an angle.

Operation 33: Mill Upper Cartridge Entrance.—This operation is accomplished on a hand milling machine, using a special fixture that holds the work at an angle to the axis of the milling cutter.

Operation 34: Cut Bolt Locking Cam Lugs.—This operation is performed on an engine lathe that has been fitted up with a special fixture and a cam type of relieving device.

Operation 35: Mill Thread for Barrel.—This is done on a thread milling machine, using a special fixture for holding the work and a special hob. At the time that the thread is being milled, the work is also marked to indicate the starting point of the thread.

Operation 36: Hand Tap Thread for Barrel.—This operation is accomplished on a special hand tapping machine, using a special tap that is started from the correct point.

Operation 37: Straddle-mill Retaining Bolt Lug.—This operation is performed on a Lincoln type milling machine, using a special fixture, one side of which is made adjustable, that holds two pieces.

Operation 38: Mill Top and Bottom of Retaining Bolt Lug.—This is done on a hand milling machine, using a special fixture.

Operation 39: Drill, Ream, and Counterbore Sear Pin Hole and Retaining Bolt Stop Hole.—These operations are accomplished on a four-spindle drilling machine, using a special jig for holding the work.

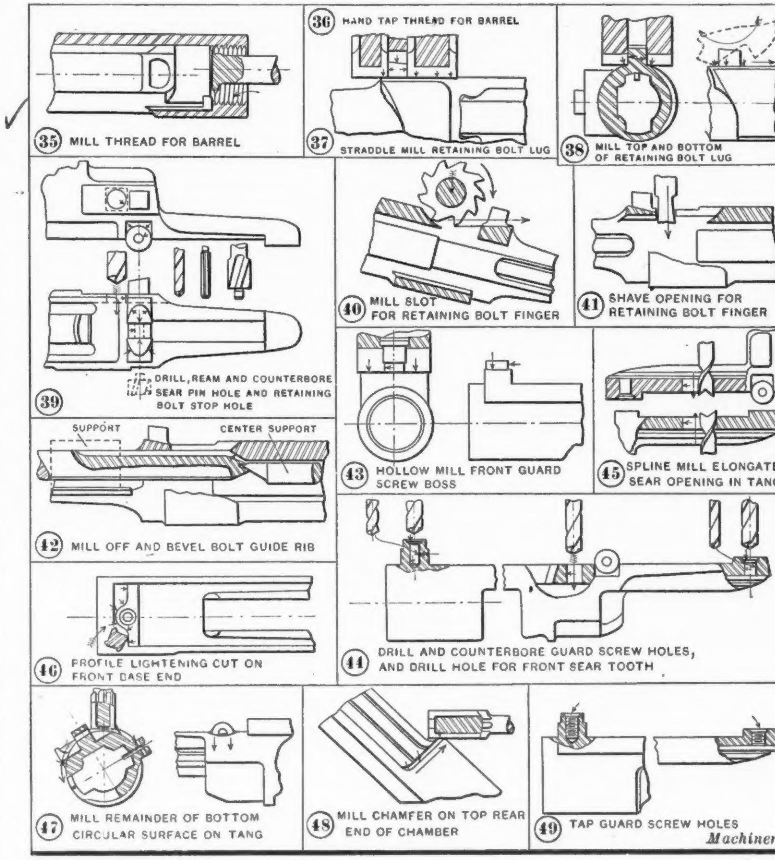


Fig. 37. Machining Operations on Spanish Mauser Receiver (Continued)

Operation 40: Mill Slot for Retaining Bolt Finger.—This operation is accomplished on a hand milling machine, using a special fixture and a slitting saw.

Operation 41: Shave Opening for Retaining Bolt Finger.—This is accomplished on a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work.

Operation 42: Mill Off and Bevel Bolt Guide Rib.—This operation is accomplished on a knee type plain milling machine, using a special fixture for holding the work. This is provided with a special center which supports the cutter, and the upper part of the fixture carrying the work is moved instead of the table of the machine.

Operation 43: Hollow-mill Front Guard Screw Boss.—This operation is accomplished on an upright drilling machine, using a special jig for holding the work and guiding the hollow milling tool.

Operation 44: Drill and Counterbore Guard Screw Holes and Drill Hole for Front Sear Tooth.—These operations are performed on a five-

spindle sensitive drilling machine, using a special jig for holding the work.

Operation 45: Spline-mill Elongated Sear Opening in Tang.—This is done on a Pratt & Whitney spline milling machine, using a special fixture that holds two pieces.

Operation 46: Profile Lightening Cut on Front Base End.—This operation is accomplished on a one-spindle profiling machine, using a special fixture for holding the work, and an outside former plate.

Operation 47: Mill Remainder of Bottom Circular Surface on Tang.—This is accomplished on a hand milling machine, using a special rotary fixture, the excess stock left in the previous operations being removed.

Operation 48: Mill Chamfer on Top Rear End of Chamber.—This operation is accomplished on a hand milling machine, using a special rotary fixture in which the work is located at an angle.

Operation 49: Tap Guard Screw Holes.—This operation is accomplished on a single-spindle drilling machine, using a tapping attachment.

Operation 50: Roll Inscriptions on Side.—This is accomplished on a Noble & Westbrook marking machine, using a special fixture for holding the work and a special roll.

Operation 51: Stamp.—This is a hand operation.

Operation 52: File and Burr.—This operation consists in removing the burrs and sharp corners.

Operation 53: Pack-harden.—See "Pack-harden."

Operation 54: Polish.—See "Polish."

Operation 55: Blue.—See "Blue—Gas Furnace Process."

OPERATIONS ON RETAINING BOLT

The retaining bolt (see Fig. 33) is made from a ¾-inch square hot-drawn gun steel bar. The first operation is to cut off pieces, preferably six at a time, to approximately the required length, leaving about 1/32 inch of stock on each end for finishing; then the part is rough-milled on the right-hand side and the top, rough cuts being first taken from all four surfaces. The bottom surface is finished and then the top. For the subsequent gaging and machining operations, the top and bottom surfaces and the rear end act as locating points. For additional details, such as feeds, speeds and production, see Table XV.

Operation 1: Cut Off to Length.—This operation is accomplished on a cutting-off machine, using a high-speed steel inserted-tooth saw. Six pieces are cut off at one time.

Operation 2: Mill Right-hand Side and Stop Lug, and Face Off to Length, Rough.—This operation is accomplished on a Lincoln type milling machine, using special vise jaws that hold two pieces. The eccentrically relieved form milling cutters are made from high-speed steel.

Operation 3: Mill Top Surface, Boss and Finger Lug, Rough.—This is done on a Lincoln type milling machine, using special vise jaws that hold two pieces. The work is located from the previously milled surface and the rough bottom.

Operation 4: Mill Bottom Surface.—This operation is performed on a Lincoln type milling machine, using special vise jaws as before.

Operation 5: Mill Left-hand Side and Slot, Rough.—This operation is accomplished on a Lincoln type milling machine, using special vise jaws that hold two pieces. The pieces are held in contact with each other and parallel with the axis of travel of the table, so that the slot is rough-milled at the same time that the left-hand surface is finished. The jaws are cut away to clear the finger lug.

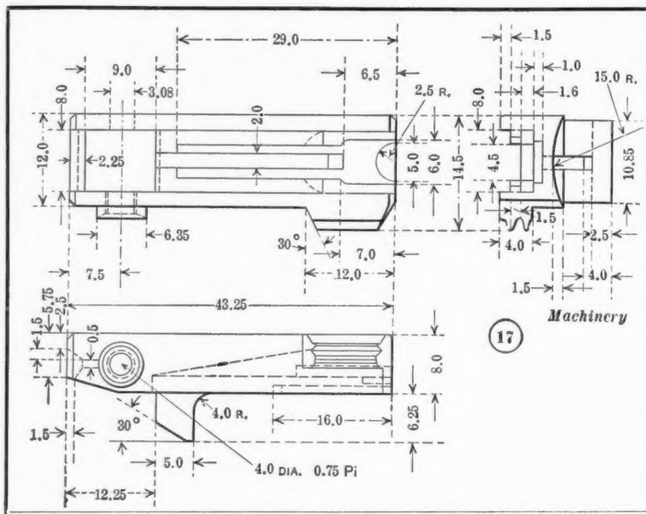
Operation 6: Mill Right-hand Side and Stop Lug, and Face Off to Length, Finish.—This operation is accomplished on a Lincoln type milling machine in the same manner as Operation 2.

Operation 7: Mill Top Surface, Boss and Finger Lug, Finish.—This is done on a Lincoln type milling machine in the same manner as Operation 3.

Operation 8: Drill Retaining Bolt Lug Clearance Hole and Hollow-mill Screw Hole Boss.—This operation is accomplished on a two-spindle upright drilling machine, using a special jig for holding the piece.

Operation 9: Spot, Drill and Ream Fulcrum Screw Hole.—

TABLE XV. OPERATIONS ON RETAINING BOLT—PART NO. 17



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to length	Cutting-off mach.	Insert-tooth H. S. steel saw	40	0.090	180	3
2	Mill right-hand side and stop lug, and face off to length, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.062	75	2
3	Mill top surface, boss and finger lug, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.062	90	2
4	Mill bottom surface	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.062	90	2
5	Mill left-hand side and slot, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.050	60	2
6	Mill right-hand side and stop lug, and face off to length, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	65	0.032	80	2
7	Mill top surface, boss and finger lug, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	65	0.032	80	2
8	Drill retaining bolt lug clearance hole and hollow-mill screw hole boss	Two-spindle upright drill. mach.	Spec. jig	60-80	Hand	50	1
9	Spot, drill and ream fulcrum screw hole	Three-spindle sensitive drill mach.	Spec. jig	40-90	Hand	50	1
10	Shave retaining bolt lug clearance hole	Vertical bench shav. mach.	Shaving tool	100 st'k's	Hand	60	1
11	Straddle-mill retaining lug	Hand mill. mach.	Spec. vise jaws	70	Hand	50	1
12	Mill receiver clearance groove	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
13	Mill remainder of top surface	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
14	Mill serrations in finger piece	Hand mill. mach.	Spec. vise jaws Spec. hob	70	Hand	60	1
15	Mill retaining bolt spring leaf clearance slot	Hand mill. mach.	Spec. vise jaws	65	Hand	25	1
16	Mill ejector spring slot	Hand mill. mach.	Spec. vise jaws	70	Hand	35	1
17	Mill retaining bolt spring locking lug clearance	Hand mill. mach.	Spec. vise jaws	70	Hand	50	1
18	Mill retaining bolt spring T-slot	Hand mill. mach.	Spec. vise jaws	70	Hand	45	1
19	Mill stop for retaining bolt spring	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
20	Mill ejector slot	Hand mill. mach.	Spec. vise jaws	65	Hand	45	1
21	File clearance on retaining bolt lug hole	......	Filing jig files	..	..	50	1
22	Tap ejector screw hole	Bench tap. mach.	Spec. jig	30	..	70	1
23	Stamp	......	Hand stamps	..	..	250	1
24	File and burr	......	Files	..	..	45	1
25	Caseharden	Cyanide furnace	......	..	..	75	..
26	Polish	Polishing lathe	Leather covered wheels	5000	Hand	45	1
27	Blue	American "bluing" gas furnace	Rack to hold work	..	..	20	1

This is accomplished on a three-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 10: Shave Retaining Bolt Lug Clearance Hole.—This is done on a Pratt & Whitney vertical bench shaving machine. A shaving tool of the "fish-tail" type is used.

Operation 11: Straddle-mill Retaining Lug.—This operation is accomplished on a hand milling machine, using special vise jaws for holding the work, one piece being milled at a time.

Operation 12: Mill Receiver Clearance Groove.—This is accomplished on a hand milling machine, using special vise jaws for holding the work, and one piece is milled at a time.

Operation 13: Mill Remainder of Top Surface.—This operation is performed on a hand milling machine, and consists in milling the remainder of the stock left at the hand lug.

Operation 14: Mill Serrations in Finger Piece.—This is accomplished on a hand milling machine, using a special type of milling cutter for finishing the serrations in one cut.

Operation 15: Mill Retaining Bolt Spring Leaf Clearance Slot.—This operation is accomplished on a hand milling machine, using a milling cutter with teeth on the sides. The cutter is fed down to the required depth, and then the table is moved longitudinally, the piece being set at the required angle to finish the angular surface of this slot.

Operation 16: Mill Ejector Spring Slot.—This is done on a hand milling machine, using special jaws for holding the piece. A cutter with side clearance is used.

Operation 17: Mill Retaining Bolt Spring Locking Lug Clearance.—This operation is accomplished on a hand milling machine, using an end-milling cutter.

Operation 18: Mill Retaining Bolt Spring T-slot.—This operation is accomplished on a hand milling machine, the work being held in special vise jaws, and the cut is made with a small T-cutter.

Operation 19: Mill Stop for Retaining Bolt Spring.—This is done on a hand milling machine, using an end-milling cutter.

Operation 20: Mill Ejector Slot.—This operation is accomplished on a hand milling machine, using special vise jaws as before. A slitting saw is used for finishing the slot, the cutter being fed down into the work to the required depth, without any traverse of the table.

Operation 21: File Clearance on Retaining Bolt Lug Hole.—This operation is performed on a special filing jig held in the vise, and consists in filing a slight angle on the clearance slot that has previously been shaved.

Operation 22: Tap Ejector Screw Hole.—This operation is accomplished on a small bench tapping machine, using a special jig for holding the work.

Operation 23: Stamp.—This is a hand operation.

Operation 24: File and Burr.—This is also a hand operation.

Operation 25: Caseharden.—See "Caseharden."

Operation 26: Polish.—See "Polish."

Operation 27: Blue.—See "Blue—Gas Furnace Process."

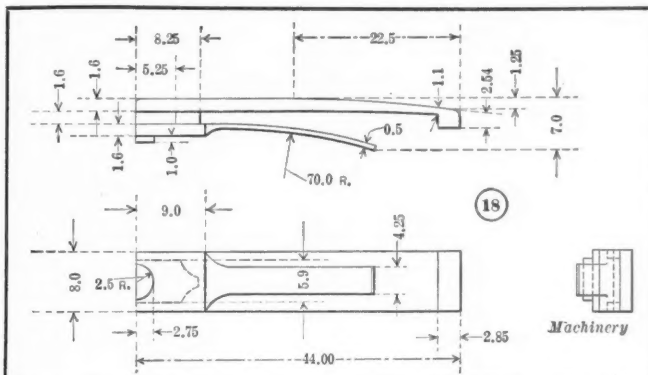
OPERATIONS ON RETAINING BOLT SPRING

The retaining bolt spring (see Fig. 33) is made from vanadium type D steel which is capable of taking a spring temper. The most economical way of making this piece is to do all the roughing in strips of a sufficient length to make ten pieces. Briefly reviewed, the preliminary steps comprise cutting off strips 4 5/16 inches long from rectangular hot-rolled stock, 1⅞ inch wide by ⅜ inch thick. The cutting-off operation is done in a cutting-off machine. The first machining operation consists in gripping ten rough strips in a vise and milling lengthwise along one edge in order to secure a point for location, in roughing out the pieces. These milled strips are subsequently cut up into pieces, allowing 0.010 inch on each side for finishing by milling. For additional details, such as feeds, speeds, and production, see Table XVI.

Operation 1: Cut Off to 4 5/16-inch Lengths.—This operation is accomplished on a cutting-off machine, in which four bars are held at one time. A high-speed steel inserted-tooth saw is used.

Operation 2: Mill One Edge.—This is accomplished on a Lincoln type milling machine, in which ten strips are held in a special vise, the milling being done lengthwise of the strips

TABLE XVI. OPERATIONS ON RETAINING BOLT SPRING—PART NO. 18



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Production per Mach.	Machs. per Operator
1	Cut off to 4 5/16 in. length	Cutting-off mach.	Insert-tooth H. S. steel saw	30	0.075	1800	2
2	Mill one edge	Lincoln type mill. mach.	Spec. vise; holds ten strips	35	0.040	2000	2
3	Mill bottom surface, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	35	0.020	200	2
4	Mill top surface, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two blanks	35	0.040	300	2
5	Mill remaining edge	Lincoln type mill. mach.	Spec. vise; holds ten blanks	35	0.040	2000	2
6	Mill bottom surface, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	45	0.015	200	2
7	Mill top surface, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	45	0.015	200	2
8	Mill ends and cut up into ten pieces	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	35	0.050	300	2
9	Remove burrs	Bench	Files	..	..	50	1
10	Mill upper edge	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	45	0.010	70	1
11	Mill lower edge	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	45	0.010	70	1
12	Profile right- and left-hand sides of ejector spring	Two-spindle profiling mach.	Spec. fixt.	50	Hand	25	1
13	Profile stop lug	One-spindle profiling mach.	Spec. fixt.	50	Hand	60	1
14	Mill right-hand slot for ejector spring	Hand mill. mach.	Spec. vise jaws	40	Hand	40	1
15	Mill left-hand slot for ejector spring	Hand mill. mach.	Spec. vise jaws	40	Hand	50	1
16	Mill right-hand locking slot	Hand mill. mach.	Spec. vise jaws	45	Hand	60	1
17	Mill left-hand locking slot	Hand mill. mach.	Spec. vise jaws	45	Hand	60	1
18	Stamp	Bench	Hand stamps	..	..	250	1
19	File and burr	Bench	Files	..	..	45	1
20	Bend retaining bolt spring	Punch press	Bending punch and die	80 st'k's	..	180	1
21	Bend ejector spring	Punch press	Bending punch and die	80 st'k's	..	180	1
22	Harden and temper	Hard. furnace Temp. bath	......	..	..	150	1
23	Polish	Polishing lathes	Leather covered wheels	5000	..	50	1
24	File and fit	Bench	Files, templet	..	..	30	1

and a special backing-up stop being provided for preventing the work from being pulled out of the vise.

Operation 3: Mill Bottom Surface, Rough.—This operation is performed on a Lincoln type milling machine, using special vise jaws arranged to hold two strips.

Operation 4: Mill Top Surface, Rough.—This is done on a Lincoln type milling machine, using special vise jaws, as before, that hold two blanks.

Operation 5: Mill Remaining Edge.—This operation is accomplished on a Lincoln type milling machine, using special vise jaws that hold ten blanks, and doing the milling lengthwise as in Operation 2.

Operation 6: Mill Bottom Surface, Finish.—This operation is performed in a similar manner to Operation 3.

Operation 7: Mill Top Surface, Finish.—This operation is similar to Operation 4.

Operation 8: Mill Ends and Cut Up into Ten Pieces.—This operation is accomplished on a Lincoln type milling machine, using two milling cutters with side teeth for milling each end

of the strip and slitting saws 3/32 inch wide, ground on the sides. The strips are held in special vise jaws in a Lincoln type milling machine. Care is taken in cutting the pieces to hold the thickness within close limits.

Operation 9: Remove Burrs.—This consists in removing the burrs thrown up in the milling operation, so that the pieces can be held without difficulty when taking the light finishing cuts from the upper and lower edges.

Operation 10: Mill Upper Edge.—This is done on a Lincoln type milling machine, using special jaws that hold two pieces.

Operation 11: Mill Lower Edge.—This operation is accomplished on a Lincoln type milling machine in a similar manner to Operation 10.

Operation 12: Profile Right- and Left-hand Sides of Ejector Spring.—This is done on a two-spindle profiling machine, in which a roughing and finishing cut are taken.

Operation 13: Profile Stop Lug.—This operation is accomplished on a single-spindle profiling machine, the work being held in a special fixture.

Operation 14: Mill Right-hand Slot for Ejector Spring.—This operation is done on a hand milling machine, and consists in slotting the piece to form the ejector spring. The cutter is fed down into the work.

Operation 15: Mill Left-hand Slot for Ejector Spring.—This is similar to Operation 14 except that the cut is much lighter. This finishes the slotting of the spring.

Operation 16: Mill Right-hand Locking Slot.—This operation is accomplished on a hand milling machine by holding the piece in special vise jaws, and using a slitting saw with side clearance for finishing the slot.

Operation 17: Mill Left-hand Locking Slot.—This is similar to Operation 16.

Operation 18: Stamp.—This is a hand operation.

Operation 19: File and Burr.—This consists in removing all the burrs from the piece and rounding the corner on the front end.

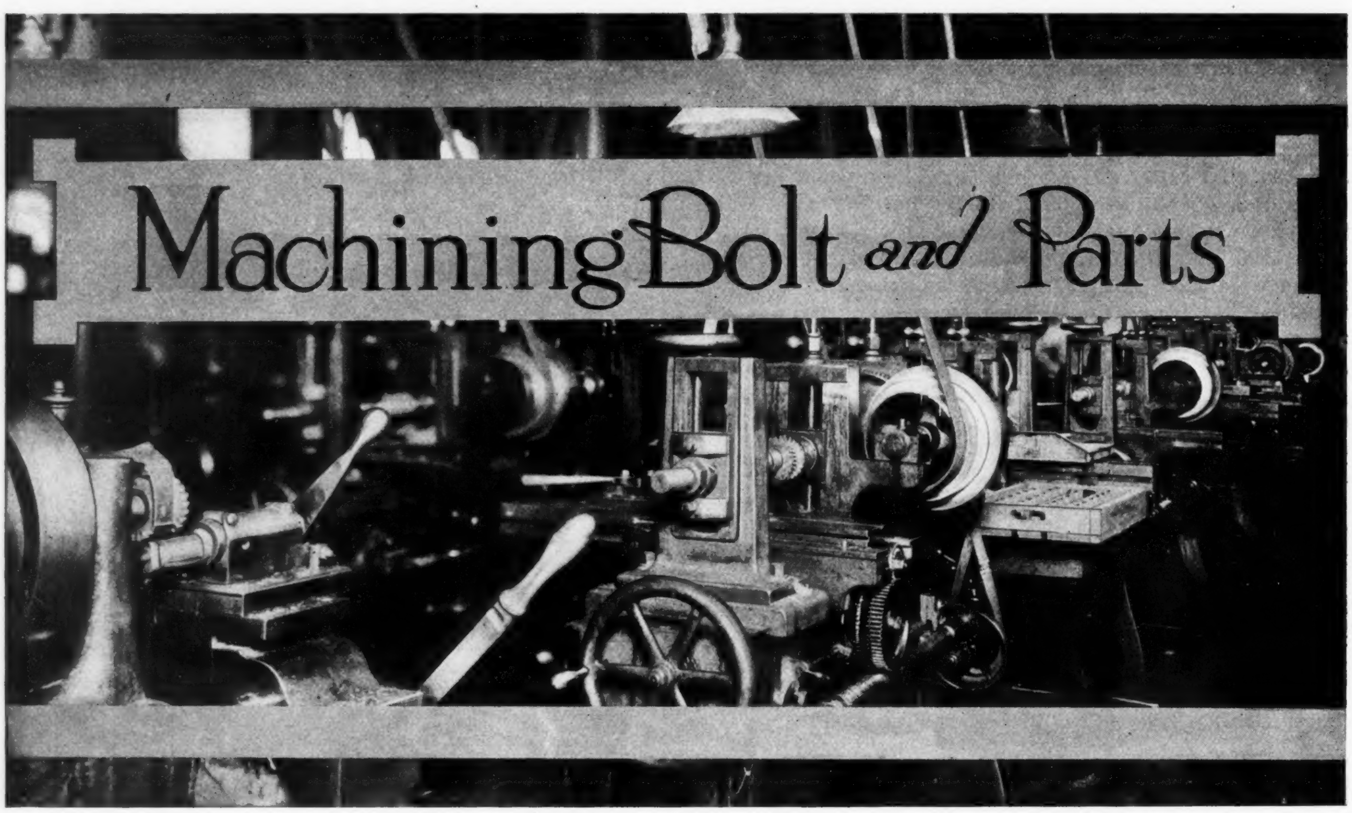
Operation 20: Bend Retaining Bolt Spring.—This operation is accomplished on a punch press, using a bending punch and die. The punch is made so that it straddles the ejector spring.

Operation 21: Bend Ejector Spring.—This is accomplished on a punch press, using a bending punch and die. In this case the bending punch is somewhat similar to a wedge, and comes down in the slot, forcing out the ejector spring to the required shape.

Operation 22: Harden and Temper.—See "Harden" and "Temper."

Operation 23: Polish.—See "Polish."

Operation 24: File and Fit.—Owing to the great accuracy required in the fit of the retaining bolt spring in the retaining bolt slot, a final hand fitting operation is necessary.



THE bolt, see Fig. 38, is drop-forged from C steel, and after forging and trimming is annealed and pickled. Following this, the ends are straddle-milled to approximate length. Two bolt forgings are then held in a pistol barrel drilling machine and the large striker holes are rough-drilled. The next operation consists in finishing this hole and counterboring, reaming, bottoming and recessing, which is done in a hand screw machine, using an adjustable jaw fixture for holding the work and floating tools in the turret. This finished hole and the faced end then act as locating and gaging points in the subsequent operations, as is clearly indicated in Figs. 39 to 42, which show graphically how each operation is accomplished. For additional information on feeds, speeds and production, see Table XVII.

Operation 1: Drop-forge and Trim.—This operation is performed on a 1200-pound drop-hammer. The bolt is forged from a one-inch bar, trimmed hot, and cut off. One operator attends to the heating furnace, hammer and trimming press.

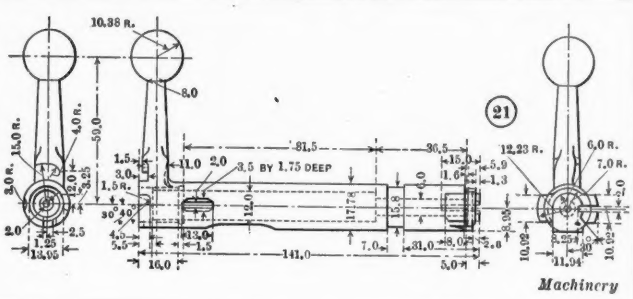
Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Straddle-mill Ends.—This operation is accomplished on a Lincoln type milling machine provided with a fixture that is arranged to hold ten pieces. The work is located from the circular portion of the rough forging. Clearance should be provided in the fixture for burrs or fins, and a rigid clamping device should be used. The cutters should be made from high-speed steel, with teeth cut slightly ahead of the radial line in order to obtain a shearing cut.

Operation 4: Drill Striker Hole, Large Diameter.—This operation is done on a pistol barrel drilling machine, using a deep-hole oil groove drill. Two forgings are located in the fixtures in V supports and clamped rigidly. One operator runs two machines, each machine having two spindles. The drill should leave about 0.005 inch for reaming.

Operation 5: Ream and Bottom Small Hole; Counterbore, Recess and Ream Large Hole; and Face Rear End.—This operation is performed on a hand screw machine provided with a special fixture or chuck of the floating type, screwed

TABLE XVII. OPERATIONS ON BOLT—PART NO. 21



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	1200-pound hammer	Forg. dies and trim. punch and die	..	..	50	1
2	Anneal and pickle	Annealing furnace pickling bath	......	..	..	..	...
3	Straddle-mill ends	Lincoln type mill. mach.	Spec. fixt. holds ten pieces	50	0.040	45	4
4	Drill striker hole, large diameter	Pistol barrel drill. mach.	Spec. fixt. barrel drill	65	0.0008	15	2
5	Ream and bottom small hole; counterbore, recess and ream large hole; and face rear end	Hand screw mach.	Spec. floating chuck and tools	30	Hand	12	1
6	Center front end; face; drill and ream small striker hole	Hand screw mach.	Spec. chuck and tools	50	Hand	30	1
7	Turn outside diameter, rough	Engine lathe	Spec. chuck shaving tools	45	0.010	40	1
8	Mill outside diameter at rear end	Hand mill. mach.	Spec. rotary fixt. and tools	45	Hand	30	1
9	Mill flat faces on handle, right and left sides	Lincoln type mill. mach.	Spec. fixt.	45	0.010	30	1
10	Mill top form of front lugs, rough and finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	45	0.032	25	2
11	Mill bottom form of front lugs, rough and finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	45	0.032	25	2
12	Turn handle knob, finish	Hand screw mach.	Spec. chuck shaving tools	30	0.010	25	1
13	Mill bolt lock stop, rough	Hand mill. mach.	Spec. rotary fixt.	50	Hand	40	1
14	Finish-turn outside diameter	Engine lathe	Spec. chuck shaving tools	40	0.010	45	1
15	Mill under side of front end of bolt	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
16	Mill front face of hand lug and diameter of body	Lincoln type mill. mach.	Spec. rotary fixt.	45	0.010	30	2
17	Mill top of lugs, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	45	0.025	25	2
18	Mill rear end diameter of body, finish	Hand mill. mach.	Spec. rotary fixt.	45	Hand	30	1
19	Mill cam corner on front left-hand side of hand lug	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
20	Mill bolt lock stop, finish	Hand mill. mach.	Spec. rotary fixt.	50	Hand	45	1
21	Mill cocking-piece lock slot	Hand mill. mach.	Spec. fixt.	45	Hand	45	1
22	Mill cocking-piece cam slot, rough	Hand mill. mach.	Spec. fixt.	45	Hand	45	1
23	Mill cocking-piece cam slot, finish	Hand mill. mach.	Spec. fixt.	50	Hand	45	1
24	Mill safety bolt tooth slot	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
25	Mill clearance slot for front tooth on sear, rough	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
26	Mill clearance slot for front tooth on sear, finish	Hand mill. mach.	Spec. fixt.	45	Hand	40	1
27	Mill uncocking clearance flat	Hand mill. mach.	Spec. fixt.	45	Hand	40	1
28	Mill front end between lugs	Hand mill. mach.	Spec. rotary fixt.	45	Hand	30	1
29	Mill extractor head clearance	Hand mill. mach.	Spec. rotary fixt.	45	Hand	35	1
30	Mill extractor groove	Hand mill. mach.	Spec. rotary fixt.	45	Hand	30	1
31	Mill ejector slot	Hand mill. mach.	Spec. fixt.	45	Hand	30	1
32	Mill radius on front end of right lug	Hand mill. mach.	Spec. rotary fixt.	45	Hand	35	1
33	Mill radius on front end	Hand mill. mach.	Spec. rotary fixt.	45	Hand	35	1
34	Tap for bolt plug	Hand oper. bench mach.	Spec. fixt. spec. taps	..	Hand	15	1
35	Turn extractor collar groove; face front end to length, and cut recess	Hand screw mach.	Spec. fixt.	45	Hand	30	1
36	Mill front end of bolt	Hand mill. mach.	Spec. index fixt.	45	Hand	40	1
37	Mill cartridge head clearance	Hand mill. mach.	Rotary fixt. with form cam	45	Hand	30	1
38	Shave rear corners of bolt lugs	Engine lathe	Spec. relieving fixture	10	Hand	20	1
39	File corners and burr	......	......	..	..	30	1
40	Pack-harden	Gas or oil furnace	Casehardening boxes	..	..	25	...
41	Polish	Polishing lathe	Leather covered wheels	4500	Hand	60	1
42	Blue	American "bluing" gas furnace	Rack to hold work	..	..	16	...
43	Polish	Polishing lathe	Leather covered wheels	4500	Hand	65	1

on the nose of the spindle. The work is located in the chuck by first being placed on a plug held in the turret. Then the clamping mechanism of the fixture is adjusted to grip it. All the tools are of the floating type so as to work from the previously drilled hole.

Operation 6: Center Front End; Face; Drill and Ream Small Striker Hole.—This operation is accomplished on a hand screw machine, the work being located from the previously drilled and reamed hole on a mandrel held in the spindle. The drilling, centering and reaming is done by using two electric drills held in suitable fixtures on the turret. The work is driven by a pin coming in contact with the bolt handle.

Operation 7: Turn Outside Diameter, Rough.—This operation is performed on an engine lathe having a power cross-feed. The work is located on one end by the tailstock center, and on the other by a special center in the spindle. The turning is accomplished with shaving tools presented tangentially and provided with vertical adjustment.

Operation 8: Mill Outside Diameter at Rear End.—This operation is accomplished on a hand milling machine, using a special rotary fixture for holding the work. The cutters are screwed onto a shank and are made from high-speed steel.

Operation 9: Mill Flat Faces on Handle, Right- and Left-hand Sides.—This is done on a Lincoln type milling machine provided with a special fixture that carries two special cutters diametrically opposed to each other. The fixture only provides for holding one piece at a time.

Operation 10: Mill Top Form of Front Lugs, Rough and Finish.—This operation is accomplished on a Lincoln type milling machine to which is attached a double fixture carrying two sets of centers for holding the work. One set of centers is arranged on a tapered wedge in order to provide for variations in the diameter of the cutters due to grinding. A roughing cut is taken from the top on one side of the fixture and a finishing cut on the other.

Operation 11: Mill Bottom Form of Front Lugs, Rough and Finish.—This is done in a similar manner to Operation 10, with the exception that interlocking milling cutters are used.

Operation 12: Turn Handle Knob, Finish.—This operation is performed on a hand screw machine provided with a special type of chuck in which the work is located from the rear end and center hole. The first cut finishes about one-third of the circle on the full end of the handle by means of an inserted-tooth blade hollow mill held in the turret. A rotating support is then brought into position to support the handle while a finishing cut is taken with a shaving tool held on the cross-slide.

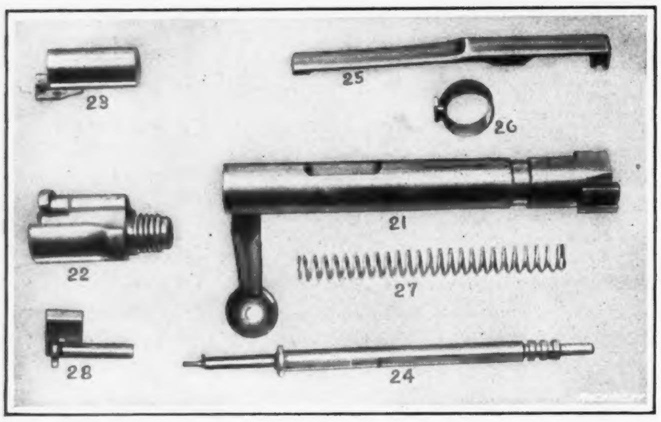


Fig. 38. Mauser Rifle Bolt, Plug, Cocking-piece, Safety Lock, Extractor, Extractor Collar, Main Spring and Striker

Operation 13: Mill Bolt Lock Stop, Rough.—This is done on a hand milling machine, using a former plate for controlling the movement of the cutter-head. The work is also held in a rotary fixture.

Operation 14: Finish-turn Outside Diameter.—This is the same as Operation 7.

Operation 15: Mill Under Side of Front End of Bolt.—In this operation the stock left at the front end of the bolt where the circular portion runs into the slot end is removed. The operation is accomplished on a hand milling machine, using a special fixture for holding the work and a form cutter for "sweeping" up to the flat portion.

Operation 16: Mill Front Face of Hand Lug and Diameter of Body.—This is accomplished on a Lincoln type milling machine, using a special rotary fixture operated by a rack on the table. A long-shank milling cutter is used that is supported near the cutter end by a special arm.

Operation 17: Mill Top of Lugs, Finish.—This operation is accomplished on a Lincoln type milling machine provided with a special fixture that holds two pieces. The work, as before, is located from the center hole and from the flat on the lugs. One set of centers on the fixture is arranged on a tapered wedge in order to provide for variations in the diameter of the cutters due to grinding. One lug is rough-milled on one side of the fixture and the other lug is finished on the opposite side.

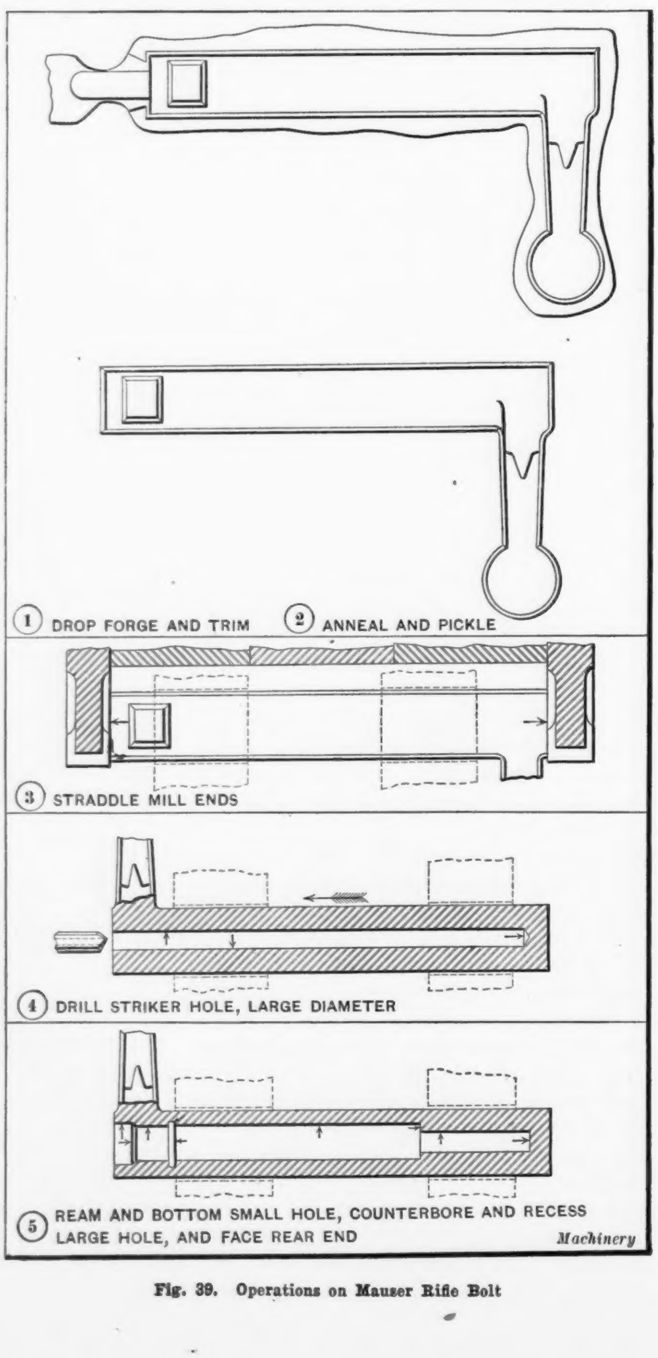


Fig. 39. Operations on Mauser Rifle Bolt

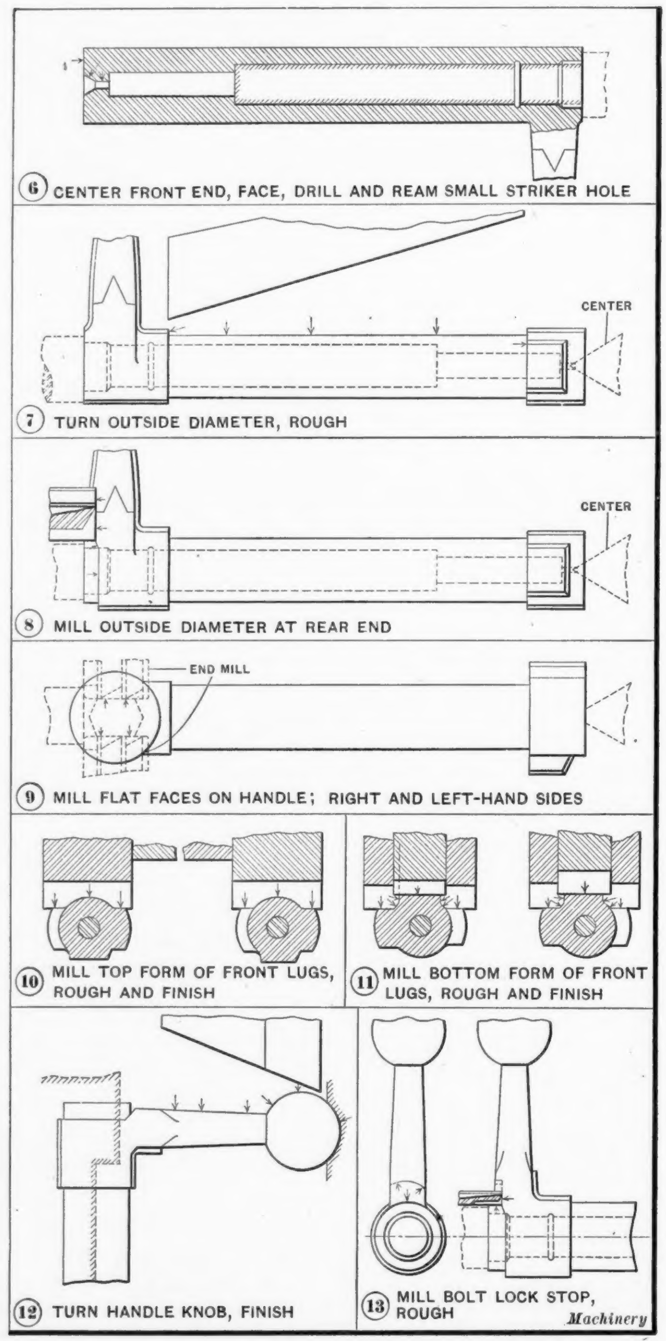


Fig. 40. Operations on Mauser Rifle Bolt (Continued)

Operation 18: Mill Rear End Diameter of Body, Finish.—This is accomplished on a hand milling machine provided with a special rotary fixture. The operation consists in finishing the portion left by the shaving and milling cuts. A long-shank cutter is used supported by a special arm, the work being located from the center hole.

Operation 19: Mill Cam Corner on Front Left-hand Side of Hand Lug.—This operation is accomplished on a hand milling machine, using a special fixture that holds the work at an

angle and provides for rotating it. An angular cutter is used, and one cut finishes the work.

Operation 20: Mill Bolt Lock Stop, Finish.—This is similar to Operation 13.

Operation 21: Mill Cocking-piece Lock Slot.—This operation is accomplished on a hand milling machine, using a special fixture for holding the work in a vertical position, and locating it from the bolt body.

Operation 22: Mill Cocking-piece Cam Slot, Rough.—This is accomplished in a similar manner to Operation 21.

Operation 23: Mill Cocking-piece Cam Slot, Finish.—This operation is accomplished on a hand milling machine, using a special rotary fixture in which the work is supported from the hole and held in an angular position in relation to the cutter.

Operation 24: Mill Safety Bolt Tooth Slot.—This is done on a hand milling machine, using a special fixture. The work is located from the center hole. An end-mill is used that is slightly smaller in radius than the cut to be made in the bolt, and the table is moved to mill the slot to the correct width.

Operation 25: Mill Clearance Slot for Front Tooth on Sear, Rough.—This operation is accomplished on a hand milling machine equipped with a special fixture which locates the work from the center hole.

Operation 26: Mill Clearance Slot for Front Tooth on Sear,

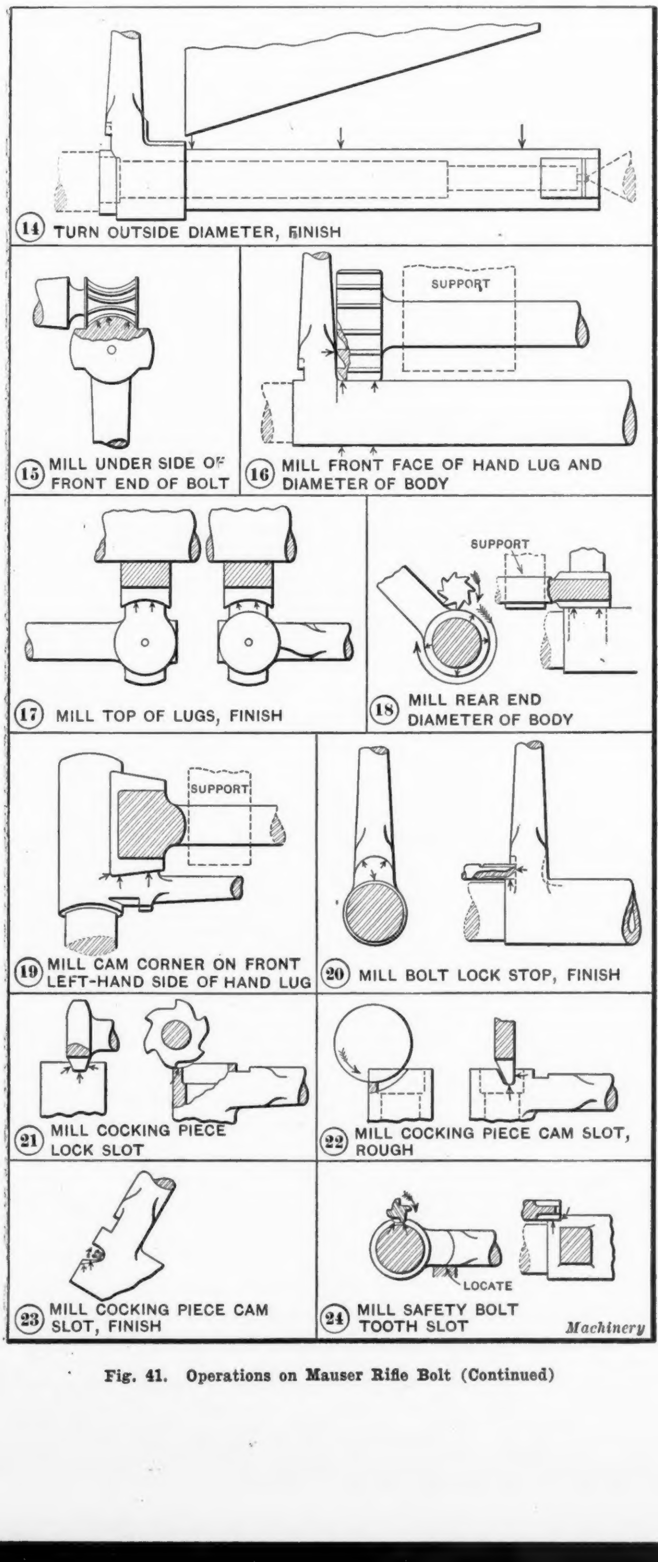


Fig. 41. Operations on Mauser Rifle Bolt (Continued)

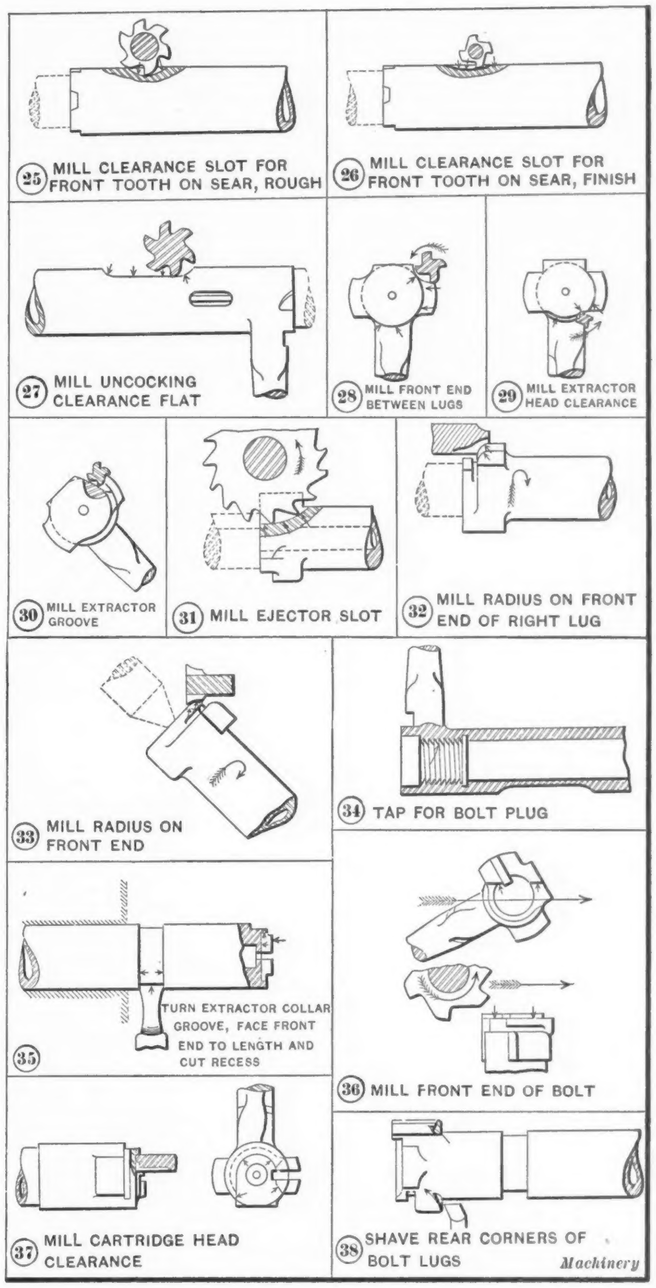


Fig. 42. Operations on Mauser Rifle Bolt (Continued)

Finish.—This is accomplished in a similar manner to Operation 25, with the exception that a smaller cutter is used.

Operation 27: Mill Uncocking Clearance Flat.—This operation is accomplished on a hand milling machine in which the work is held on a special fixture and located from the center hole and from the flat on the hand lug.

Operation 28: Mill Front End Between Lugs.—This operation is accomplished on a hand milling machine, using a special rotary fixture.

Operation 29: Mill Extractor Head Clearance.—This is accomplished on a hand milling machine, using a special rotary fixture.

Operation 30: Mill Extractor Groove.—This operation is accomplished on a hand milling machine, using a special rotary fixture, the work being located from the center hole, as in the previous cases.

Operation 31: Mill Ejector Slot.—This is done on a hand milling machine in which the work is located from the center hole. A metal slitting saw is fed in to depth and not traversed to cut the slot.

Operation 32: Mill Radius on Front End of Right Lug.—This operation is accomplished on a hand milling machine, using a special rotary fixture, and the work is located from the center hole. A formed end-mill is used.

Operation 33: Mill Radius on Front End.—This operation is accomplished on a hand milling machine, using a special fix-

ture of the rotary type, which presents the work in an angular position to the milling cutter.

Operation 34: Tap for Bolt Plug.—This is accomplished on a special hand tapping fixture in which the work is located from the rear end. The lead of the tap as well as the position at which the thread starts is controlled by a lead-screw in the fixture. This thread is of a modified buttress form having an angle of 3 degrees and 45 minutes in order to obtain a slight clearance.

Operation 35: Turn Extractor Collar Groove; Face Front End to Length, and Cut Recess.—This is done on a hand screw machine, using a special fixture in which the work is gripped on the outside. This operation finishes the bolt to length, recesses the hole for the cartridge head, and cuts the groove for the extractor collar.

Operation 36: Mill Front End of Bolt.—This operation is accomplished on a hand milling machine, using a special fixture that holds the work in a vertical position, locating from the outside. This cut prepares the end of the bolt for the final milling cut for the cartridge head clearance, removing much of the excess material.

Operation 37: Mill Cartridge Head Clearance.—This operation is performed on a hand milling machine, using an end-milling cutter, a rotary fixture for holding the work, and a forming cam to control the movement of the cutter-head.

Operation 38: Shave Rear Corners of Bolt Lugs.—This is done on an engine lathe, using a special relieving fixture similar to that used for relieving cutters.

Operation 39: File Corners and Burr.—This is a hand operation.

Operation 40: Pack-harden.—See "Pack-harden."

Operation 41: Polish.—See "Polish."

Operation 42: Blue.—See "Blue—Gas Furnace Process."

Operation 43: Polish.—See "Polish."

OPERATIONS ON BOLT PLUG

The bolt plug (see Fig. 38) is drop-forged from a hot-drawn 1⅛-inch bar of C steel. After forging, trimming, annealing and pickling, the first machining operation is performed in a turret lathe where the work is held in a special chuck and the cocking-piece hole is spotted, drilled, counterbored, reamed and the end faced. This hole then acts as a locating point for the subsequent machining operations. For additional information on feeds, speeds, and production, see Table XVIII.

Operation 1: Drop-forge and Trim.—The drop-forging operation is accomplished on an 800-pound drop-hammer, using forging dies; the trimming is done in a trimming press, using trimming punches and dies.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Spot, Drill, Counterbore, Ream and Face Striker and Cocking-piece Hole.—This operation is accomplished on a turret lathe, using a special chuck for holding the work. The machining operations are performed in the order given.

Operation 4: Turn, Face and Counterbore Tang.—This is accomplished on a turret lathe, using a special chuck for holding the work. This chuck has adjustable jaws and is provided with a hardened and ground plunger on which the work is located from the center hole.

Operation 5: Spot, Drill, Ream, Counterbore and Face Safety Lock Hole.—This operation is also accomplished on a turret lathe, using a special chuck for holding the work; the locating pin on which the work is held is eccentric to the axis of the spindle, so as to bring the safety lock hole in the correct position. The work is located from the rear end, being held in place by a screw clamp bushing.

Operation 6: Mill Lower Surface and Guide Ribs, and Sear Tooth Slot, Rough.—This operation is performed on a Lincoln type milling machine, using a special fixture that holds two pieces. The work is located from the cocking-piece hole.

Operation 7: Mill Left Guide Lug and Safety Bolt Lock Projecting Boss, Rough.—This is done on a Lincoln type milling machine, using a special fixture that holds two pieces.

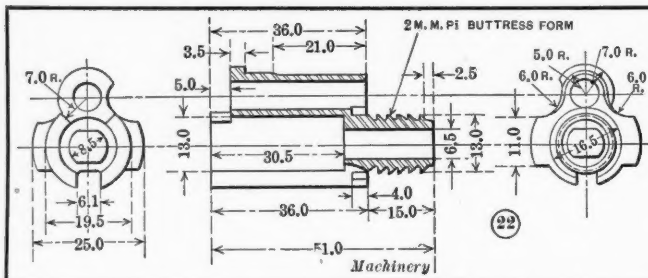
Operation 8: Mill Right Guide Lug and Safety Lock Projecting Boss, Rough.—This is accomplished in a similar manner to Operation 7.

Operation 9: Mill Remainder of Left Side.—This operation is accomplished on a Lincoln type milling machine, and consists in milling that portion remaining between the parts milled in Operations 6 and 7.

Operation 10: Mill Remainder of Right Side.—This is similar to Operation 9.

Operation 11: Sweep-mill Safety Lock Locking Rib and Boss, Rough.—This operation is accomplished on a hand milling ma-

TABLE XVIII. OPERATIONS ON BOLT PLUG—PART NO. 22



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-lb. drop-hammer	Forging and trimming dies	..	..	65	1
2	Anneal and pickle	Annealing furn. Pickling bath	......	..	..	100	..
3	Spot, drill, counterbore, ream and face striker and cocking-piece hole	Turret lathe	Spec. chuck	30-65	0.004-0.012	30	1
4	Turn, face and counter-bore tang	Turret lathe	Spec. mandrel chuck	30-65	0.004-0.010	50	1
5	Spot, drill, ream, counter-bore and face safety lock hole	Turret lathe	Spec. fixt.	30-65	0.004-0.010	55	1
6	Mill lower surface and guide ribs, and sear tooth slot, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	50	2
7	Mill left guide lug and safety lock projecting boss, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
8	Mill right guide lug and safety lock projecting boss, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
9	Mill re-mainder of left side	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
10	Mill re-mainder of right side	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
11	Sweep-mill safety lock locking rib and boss, rough	Hand mill. mach.	Spec. rotary fixt.	50	Hand	40	1
12	Sweep-mill remainder of safety lock locking boss, rough	Hand mill. mach.	Spec. rotary fixt.	50	Hand	50	1
13	Mill cocking-piece tooth slot, finish	Lincoln type mill. mach.	Spec. fixt. holds six pieces	75	0.012	200	2
14	Mill lower surface and guide ribs, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.012	60	2
15	Mill re-mainder of left side, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.012	65	2
16	Mill re-mainder of right side, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.012	65	2
17	Sweep-mill safety lock locking rib and boss, finish	Hand mill. mach.	Spec. rotary fixt.	75	Hand	60	1
18	Sweep-mill re-mainder of safety lock locking boss, finish	Hand mill. mach.	Spec. rotary fixt.	75	Hand	75	1
19	Broach striker hole	No. 1 Lapointe broaching mach.	Spec. broach	..	..	40	1
20	Mill thread on tang	Thread mill. mach.	Spec. chuck Hob cutter	50	0.005	45	2
21	Stamp	......	Hand stamps	..	..	250	1
22	File and burr	......	Files	..	..	60	1
23	Pack-harden	Gas or oil furnace	Case-hardening boxes	..	..	50	1
24	Polish	Polishing lathes	Leather covered wheels	4500	..	40	1
25	Blue	Niter bath tank	......	..	..	See text	

chine, using a special rotary fixture. The work is located on a plug fitting in the safety bolt hole.

Operation 12: Sweep-mill Remainder of Safety Lock Locking Boss, Rough.—This is also accomplished on a hand milling machine, using a special rotary fixture and rotating the work on the safety lock hole axis. The operation is performed on the front end of the boss.

Operation 13: Mill Cocking-piece Tooth Slot, Finish.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds six pieces, which are held on close fitting plugs that enter the cocking-piece hole.

Operation 14: Mill Lower Surface and Guide Ribs, Finish.—This is accomplished in a similar manner to Operation 6.

Operation 15: Mill Remainder of Left Side, Finish.—This is similar to Operation 9.

Operation 16: Mill Remainder of Right Side, Finish.—This is accomplished in a similar manner to Operation 10.

Operation 17: Sweep-mill Safety Lock Locking Rib and Boss, Finish.—This is done on a hand milling machine in a similar manner to Operation 11.

Operation 18: Sweep-mill Remainder of Safety Lock Locking Boss, Finish.—This is similar to Operation 12.

Operation 19: Broach Striker Hole.—This operation is accomplished on a No. 1 Lapointe broaching machine, using a special broach.

Operation 20: Mill Thread on Tang.—This is accomplished on a thread milling machine, using a special chuck for holding the work and a hob type of cutter.

Operation 21: Stamp.—This is a hand operation.

Operation 22: File and Burr.—This is also a hand operation.

Operation 23: Pack-harden.—See "Pack-harden."

Operation 24: Polish.—See "Polish."

Operation 25: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON COCKING-PIECE

The cocking-piece (see Fig. 38), which is subjected to considerable wear and shock, is made from a 7/8-inch round bar of hot-drawn C steel. The first machining operation is accomplished in a muitiple-spindle automatic screw machine, where the bar is turned to form the rear part of the body, spotted, drilled, faced, chamfered, and cut off. For the second operation, which consists in reaming, counterboring, facing and recessing the opposite end, the work is held by the finished shank. This machined body then acts as a locating point for the subsequent machining and gaging operations. For additional information on feeds, speeds, and production, see Table XIX.

Operation 1: Turn, Spot, Drill, Face, Chamfer and Cut Off.—This operation is accomplished on a four-spindle automatic screw machine, using an eccentric collet for holding the work. The operations are performed in the order listed.

Operation 2: Ream, Counterbore, Face and Recess.—This is accomplished on a hand screw machine, holding the work in a chuck by the external diameter.

Operation 3: Mill Right and Left Sides of Body and Cocking-piece Tooth, Rough.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces.

Operation 4: Mill Bottom of Tooth, Rough.—This is done on a hand milling machine, using a quick-action vise provided with special jaws that hold two pieces.

Operation 5: Mill Right and Left Sides of Body and Cocking-piece Tooth, Finish.—This is similar to Operation 3.

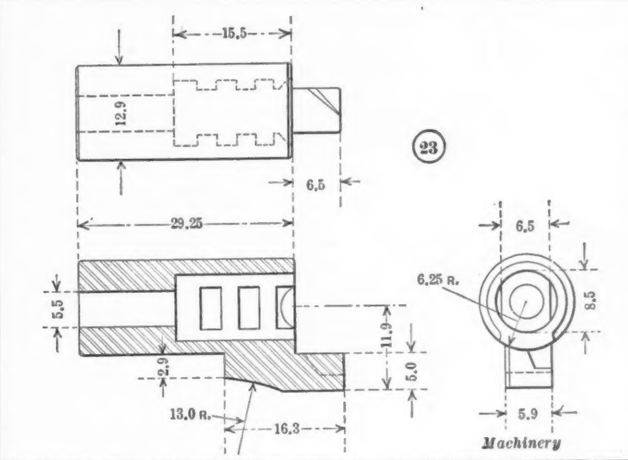
Operation 6: Mill Bottom of Tooth, Finish.—This is accomplished in a similar manner to Operation 4.

Operation 7: Mill Bolt Tooth Lock Cam.—This operation is accomplished on a hand milling machine, using a special rotary fixture that holds one piece.

Operation 8: Mill Chamfer on Front End of Body.—This is also accomplished on a hand milling machine, using a special rotary fixture that holds one piece, and a bevel type of end-milling cutter.

Operation 9: Shave Striker Locking Flats.—This operation is accomplished in a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work and a special shaving tool; one piece is held at a time.

TABLE XIX. OPERATIONS ON COCKING-PIECE—PART NO. 23



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Turn, spot, drill, face, chamfer and cut off	Multi-spindle auto. screw mach.	Ecc. collet	65	0.010-0.020	60	3
2	Ream, counterbore, face and recess	Hand screw mach.	Tools and fixtures	30-65	0.010	40	1
3	Mill right and left sides of body and cocking-piece tooth, rough	Lincoln type mill. mach.	Mill. cutter and fixt. holds two pieces	65	0.020	50	2
4	Mill bottom of tooth, rough	Hand mill. mach.	Vise jaws; hold two pieces	65	Hand	60	1
5	Mill right and left sides of body and cocking-piece tooth, finish	Lincoln type mill. mach.	Mill. cutter and fixt. holds two pieces	65	0.010	50	2
6	Mill bottom of tooth, finish	Hand mill. mach.	Vise jaws; hold two pieces	65	Hand	60	1
7	Mill bolt tooth lock cam	Hand mill. mach.	Rotary fixture	60	Hand	50	1
8	Mill chamfer on front end of body	Hand mill. mach.	Rotary fixture	60	Hand	50	1
9	Shave striker locking flats	P. & W. bench upright shaving mach.	Fixture and tools	100 st'k's	Hand	30	1
10	Stamp	Bench work	Hand stamps	..	..	250	1
11	File and burr	Bench work	Files	..	..	40	1
12	Pack-harden	Gas or oil furnace	Casehardening boxes	..	..	50	..
13	Polish	Polishing lathe	Leather covered wheels	4500	..	40	1
14	Blue	Niter bath tank	......	..	..	See text	

Operation 10: Stamp.—This is a hand operation.

Operation 11: File and Burr.—This is also a hand operation.

Operation 12: Pack-harden.—See "Pack-harden."

Operation 13: Polish.—See "Polish."

Operation 14: Blue.—See "Blue—Niter Bath Process."

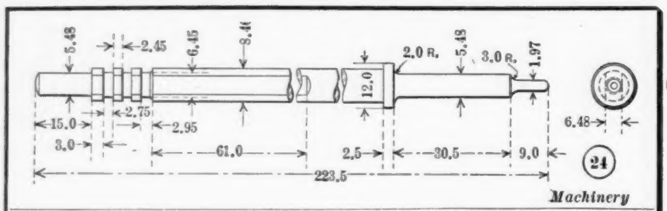
OPERATIONS ON STRIKER

The striker (see Fig. 38) is subjected to severe service, and is made from best grade tool steel. The first operation, which is performed on a 1¼-inch multiple spindle automatic screw machine, consists in rough-turning a 9/16-inch diameter round bar on one end to the size required. The piece is then reversed and the opposite end finished in a hand screw machine. For additional information on feeds, speeds, and production, see Table XX.

Operation 1: Turn Body to Shoulder, Cocking-piece Diameter, Face, Groove and Cut Off.—This operation is accomplished on an automatic screw machine provided with standard tools. Particular attention should be given to the quality of finish obtained, in order to avoid later polishing operations.

Operation 2: Turn and Form Front End.—This operation is performed on a hand screw machine. After roughing out with two box-tools, the work is clamp milled in order to size the firing pin diameter and finish the form with the smoothest pos-

TABLE XX. OPERATIONS ON STRIKER—PART NO. 24



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Turn body to shoulder, cocking piece diameter, face, groove and cut off	1¼" mult. spin. auto. s. m.	Spec. tools	45	0.004	30–35	3
2	Turn and form front end	Hand screw mach.	Std. box-tools. Spec. clamp mill	60	Hand	25–30	1
3	Mill flats on sides	Hand mill. mach.	Index. fixt. H. S. steel cutter	60	Hand	80	1
4	Stamp	Bench work	Stamps	..	..	250	1
5	File and burr	Bench work	Files Filing jig	..	..	30	1
6	Harden and temper	Hard. and temp. bath	......	..	..	100	..
7	Polish rear end	Polishing lathe	Leather covered wheels	4500	Hand	200	1
8	Blue	Niter bath, tank	Spec. tongs to hold work	..	..	250	1

sible surface. This clamp milling operation is necessary in order to secure a perfectly formed point on the firing pin.

Operation 3: Mill Flats on Sides.—This is done on a hand milling machine, by holding the work in an indexing fixture, and using an end-milling cutter.

Operation 4: Stamp.—This is a hand operation.

Operation 5: File and Burr.—This is also a hand operation, in which a filing jig is used to finish the radius on the flats of the body, and remove burrs.

Operation 6: Harden and Temper.—See "Harden" and "Temper."

Operation 7: Polish Rear End.—See "Polish."

Operation 8: Blue.—This operation is performed on the rear end of the striker only, in a niter bath.

OPERATIONS ON EXTRACTOR

The extractor (see Fig. 38) which is subjected to considerable hard use and wear is made from a hot-drawn bar of 7/16-inch square vanadium type D steel, and carefully hardened and tempered. The first operation is cutting off to approximate length in a cutting-off machine holding six pieces at one time. Following this, both sides are ground on a Blanchard vertical surface grinder. Then the top surface is ground, using a special magnetic chuck which has radial slots into which the work fits closely, registering from the ground sides. Following this, the sides and top act as locating and gaging points. For feeds, speeds, production, etc., see Table XXI.

Operation 1: Cut Off from Bar Stock.—This operation is accomplished on a Higley cutting-off machine, using a high-speed steel inserted-tooth saw, and holding six pieces at one setting.

Operation 2: Surface Grind Right- and Left-hand Sides.—These operations are accomplished on a Blanchard vertical surface grinder in which eighty pieces are held on the magnetic chuck at one setting. From 0.015 to 0.020 inch is removed from each side, and the limits are ± 0.001 inch. The wheel used is silicate corundum, 16 inches in diameter, 1½ inch rim, grain 30, grade ¾, rotating at 4190 surface feet per minute. The speed of the work-table is roughing, 17 R. P. M.; finishing, 5 R. P. M. The down feed of the wheel-spindle is 0.001 inch per revolution of the work-table.

Operation 3: Surface Grind Top.—This is also accomplished on a Blanchard vertical surface grinder, but the work is not held directly on the magnetic chuck. A special plate with radial grooves of a width equal to the finish-ground work is fastened to the magnetic chuck, and thirty pieces of work are slipped into these slots. The other data, feeds, etc., are the same as for Operation 2.

Operation 4: Mill Ends and Bottom Surfaces.—This operation is accomplished on a Lincoln type milling machine, using a standard quick-action vise, equipped with special jaws for holding four pieces. The interlocking type of milling cutters is used.

Operation 5: Mill Remainder of Bottom.—This is accomplished on a Lincoln type milling machine, using a standard quick-action vise provided with special jaws for holding two pieces. These vise jaws are milled with the form milling cutters used for milling the piece, to approximately the same shape and height as the work, so as to support it rigidly at all points.

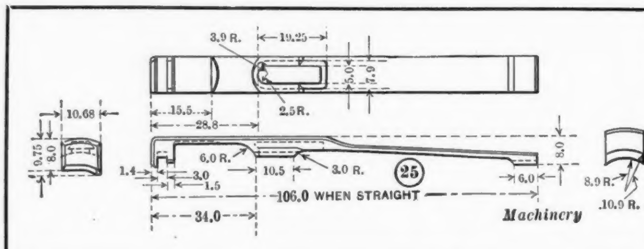
H *Operation 6: Mill Rear Stop.*—This is done on a hand milling machine, using a standard quick-action vise with jaws that hold one piece.

Operation 7: Mill Holding Lug.—This operation is accomplished on a hand milling machine, using a standard quick-action vise that holds one piece.

Operation 8: Mill Clearance for Bolt Lug.—This is accomplished on a hand milling machine, using a standard quick-action vise that holds one piece. In this case, the cutter-spindle is dropped down without traverse of the table.

Operation 9: Mill Recess in Rear of Hook.—This operation is accomplished on a hand milling machine, using a standard quick-action vise with special jaws that hold one piece. The

TABLE XXI. OPERATIONS ON EXTRACTOR—PART NO. 25



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off from bar stock	Higley cutting-off saw	H. S. steel inserted-tooth blade saw	30	0.062	100	2
2	Surf. grind right- and left-hand sides	Blanchard surface grinder	Silicate corundum wheel	See	text	200-250	1
3	Surface grind top	Blanchard surface grinder	Silicate corundum wheel	See	text	200-250	1
4	Mill ends and bottom surfaces	Lincoln type mill. machine	Std. quick-action vise; holds four pieces	40	0.025	80	2
5	Mill remainder of bottom	Lincoln type mill. machine	Std. quick-action vise; holds two pieces	60	1/32	70	2
6	Mill rear stop	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	75	1
7	Mill holding lug	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	65	1
8	Mill clearance for bolt lug	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	50	1
9	Mill recess in rear of hook	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	50	1
10	Mill slot for collar	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	45	1
11	Mill undercut for collar	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	30	1
12	Mill hook and front corners	Hand mill. machine	Std. quick-action vise; with former plate	65	Hand	50	1
13	Mill front stop	Hand mill. machine	Std. quick-action vise; with former plate	65	Hand	50	1
14	Mill spring relief cut	Hand mill. machine	Spec. vise jaws; hold one piece	65	Hand	40	1
15	Mill relief cut on top, rough	Lincoln type mill. mach.	Std. quick-action vise; holds two pieces	60	0.030	60	2
16	Mill relief cut on top, finish	Hand mill. machine	Std. quick-action vise; with former plate	60	Hand	40	1
17	Mill front bevels	Hand mill. machine	Spec. rotary fixture	65	Hand	60	1
18	Bend	Bench fixt.	Bending punch and die	..	..	120	1
19	File corners and burr	Bench work	Files	..	..	25	1
20	Harden and temper	Hard. furn. Temp. bath.	......	..	..	150	1
21	Polish	Polishing lathe	Leather covered wheels	5000	..	30	1

spindle is also dropped down in this case.

Operation 10: Mill Slot for Collar.—This is done on a hand milling machine, using an end-milling cutter and holding the work in a standard quick-action vise.

Operation 11: Mill Under-cut for Collar.—This operation is accomplished on a hand milling machine, using a standard quick-action vise and an end-milling cutter.

Operation 12: Mill Hook and Front Corners.—This operation is performed on a hand milling machine, using a standard quick-action vise for holding the work. The movement of the cutter is controlled by a former plate fastened to the fixture.

Operation 13: Mill Front Stop.—This is accomplished on a hand milling machine, using a standard quick-action vise, with a former plate that controls the movement of the milling cutter.

Operation 14: Mill Spring Relief Cut.—This operation is accomplished on a hand milling machine by holding the work in special vise jaws, and supporting the shank milling cutter on the outer end by a center held in the over-arm. The table is traversed in line with the axis of the machine spindle.

Operation 15: Mill Relief Cut on Top, Rough.—This is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. One side of the fixture is made adjustable to compensate for variation in the diameters of the cutters.

Operation 16: Mill Relief Cut on Top, Finish.—This operation is performed on a hand milling machine, using a standard quick-action vise with special jaws that hold one piece. The movement of the cutter is controlled by a former plate on the fixture.

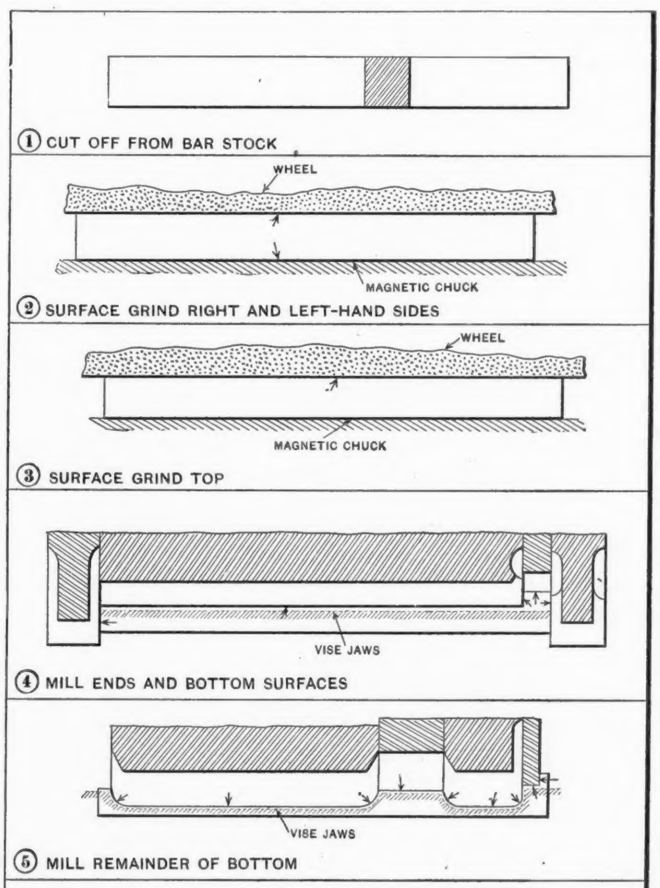


Fig. 43. Operations on Mauser Rifle Extractor

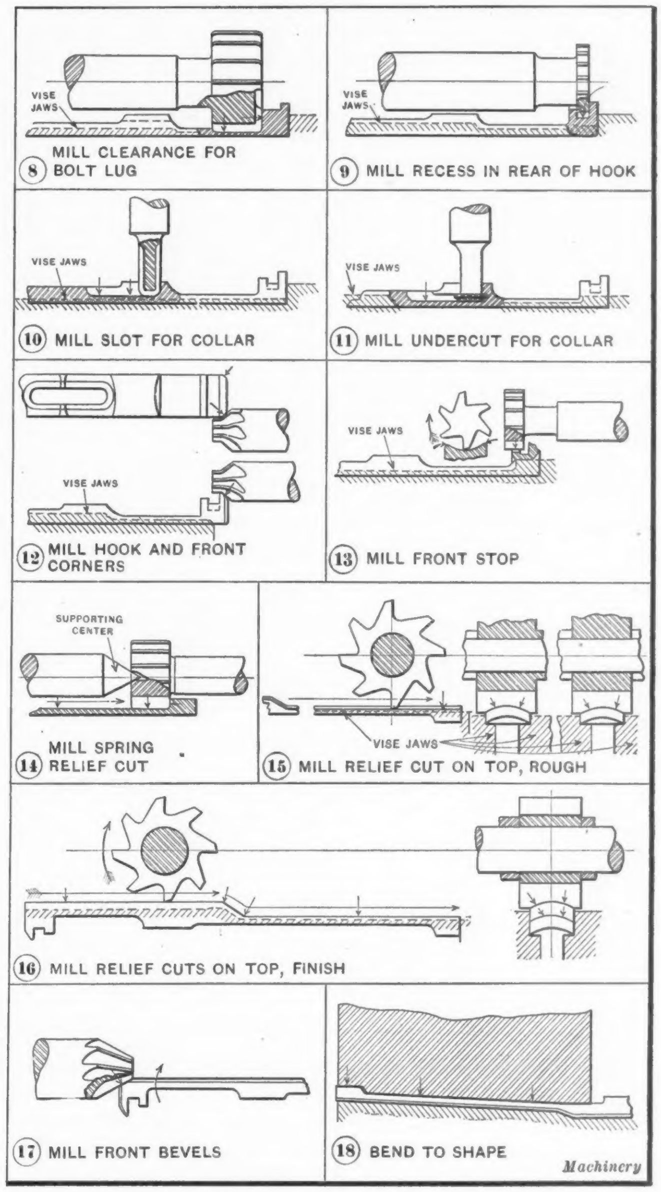


Fig. 44. Operations on Mauser Rifle Extractor (Continued)

Operation 17: Mill Front Bevels.—This operation is accomplished on a hand milling machine, using a special rotary fixture that holds one piece.

Operation 18: Bend.—This is accomplished in a special bench fixture operated by hand.

Operation 19: File Corners and Burr.—This is a hand operation.

Operation 20: Harden and Temper.—See "Harden" and "Temper."

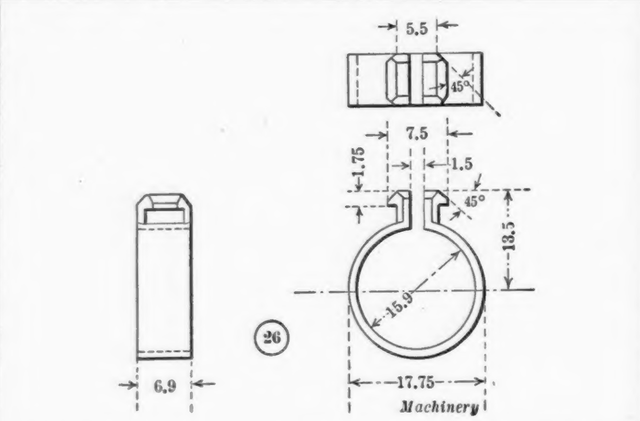
Operation 21: Polish.—See "Polish."

OPERATIONS ON EXTRACTOR COLLAR

The extractor collar (see Fig. 38) which must be hardened and spring tempered is made from a 1¼-inch hot-rolled bar of vanadium type D, mild steel. The first operation consists in drilling and reaming the hole, facing one end and cutting off in a multiple spindle automatic screw machine. These finished surfaces then act as locating and gaging points for subsequent operations, the complete sequence of which is shown in Fig. 45. For additional data, such as feeds, speeds, and production, see Table XXII.

Operation 1: Drill, Ream, Face and Cut Off.—This operation is accomplished on a 1¼-inch four-spindle automatic screw machine, using standard tools. Large stock is used so that it can be held concentrically and thus avoid the trouble usually experienced in cutting off eccentric stock.

TABLE XXII. OPERATIONS ON EXTRACTOR COLLAR—PART NO. 26



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drill, ream face and cut off	1¼" mult. spin. auto. screw. mach.	1 drill H. S. steel 1 reamer	60	0.006	160	2
2	Surface-grind one side	Blanchard surface grinder	Grinding wheel	See text	0.001	800–1000	1
3	Mill top and sides of lug	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	1/32	60	2
4	Mill outside edge	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	1/32	60	2
5	Mill under-cut for extractor	Hand mill. mach.	Spec. fixt. holds two pieces	75	Hand	40	1
6	Mill radius on corners	Hand mill. mach.	Spec. fixt. and former	75	Hand	65	1
7	Mill slot to open	Hand mill. mach.	Spec. fixt.	75	Hand	90	1
8	File corners and burr	..	Bench oper.	..	..	50	..
9	Harden and temper	Hard. and temp. bath	..	..	..	150	..
10	Tumble	Ball burnishing mach.	..	..	..	25	5

Operation 2: Surface-grind One Side.—This is accomplished on a Blanchard vertical surface grinder, holding 400 pieces on the magnetic chuck. The wheel used is 16 inches diameter, 1½ inch face, silicate corundum, grain 30, grade ¾, rotating at 4190 feet surface speed. The table speeds are roughing, 17 R. P. M.; finishing, 5 R. P. M. The depth of cut is 0.001 inch per revolution of the work-table.

Operation 3: Mill Top and Sides of Lug.—This operation is accomplished on a Lincoln type milling machine provided with a special fixture for holding two pieces.

Operation 4: Mill Outside Edge.—This operation, which is accomplished on a Lincoln type milling machine, consists in milling the remainder of the outside circular surface to size and shape in two settings. The fixture holds two pieces, and half the diameter is milled on one side, the remainder being finished on the other side of the fixture, one piece being completed at each pass of the work under the cutters.

Operation 5: Mill Under-cut for Extractor.—This operation is accomplished on a hand milling machine, using a special fixture that holds two pieces. The work is arranged so that opposing sides of the under-cut are milled on each side of the fixture, one piece being completed at each pass of the work under the cutters.

Operation 6: Mill Radius on Corners.—This is done on a hand milling machine provided with a special fixture for holding one piece, and a roller on the spindle arranged to follow a former plate on the fixture, thus forming both corners at one setting.

Operation 7: Mill Slot to Open.—This is accomplished on a hand milling machine, using a special fixture to hold one piece and a slitting saw.

Operation 8: File Corners and Burr.—This is a hand operation, consisting in removing the sharp corners from the lug.

Operation 9: Harden and Temper.—See "Harden" and "Temper."

Operation 10: Tumble.—See "Tumble."

OPERATIONS ON SAFETY LOCK

The safety lock (see Fig. 38) is made from lockwork steel by drop-forging. After forging and trimming, the forging is annealed and pickled, after which it is ready for the first machining operation. This consists in finishing the stem, drilling the clearance hole and facing the shoulder on the flange. The work is done in a five-spindle upright drilling machine, using a special jig for holding the work that can be turned over for drilling and milling the clearance hole and located in an upright position for hollow-milling the stem. The stem and this finished shoulder then act as locating points for the subsequent milling and gaging operations. For feeds, speeds, production, etc., see Table XXIII.

Operation 1: Drop-forge and Trim.—This operation is accomplished on an 800-pound drop-hammer, using forging dies, and the trimming is done in a trimming press, using a trimming punch and die.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Hollow-mill Stem, Drill and Mill Clearance Hole and Face Shoulder.—This operation is accomplished on a five-spindle upright drilling machine, using a special jig for holding the work and performing the operations in the following order: First, rough hollow-mill stem down to top of thumb piece; second, finish-mill stem down to shoulder; third, drill clearance hole in thumb piece; fourth, mill out clearance slot in thumb piece; and fifth, face shoulder and clearance slot with a T-end hollow mill. To perform this last operation it is necessary to stop the machine so the slotted mill can pass the thumb piece without interference. This tool is brought down to a swinging stop to locate it before the spindle is started. The first and the last hollow mill carry facing tools for facing off the end of the stem to length.

Operation 4: Mill Right- and Left-hand Sides of Thumb Piece, Boss and Top, Rough.—This is accomplished on a Lincoln type milling machine, using a special fixture provided with V-type jaws that hold two pieces. On one side of the fixture the right-hand side of the work is milled, and on the other side the left-hand side. One side of the fixture is made adjustable so as to compensate for variation in the diameter of the cutters.

Operation 5: Mill Right- and Left-hand Sides of Thumb Piece, Boss and Top, Finish.—This is done in a similar manner to Operation 4.

Operation 6: Straddle-mill Front and Rear Ends of Thumb Piece.—This operation is accomplished on a Lincoln type milling machine, using two side milling cutters separated by spac-

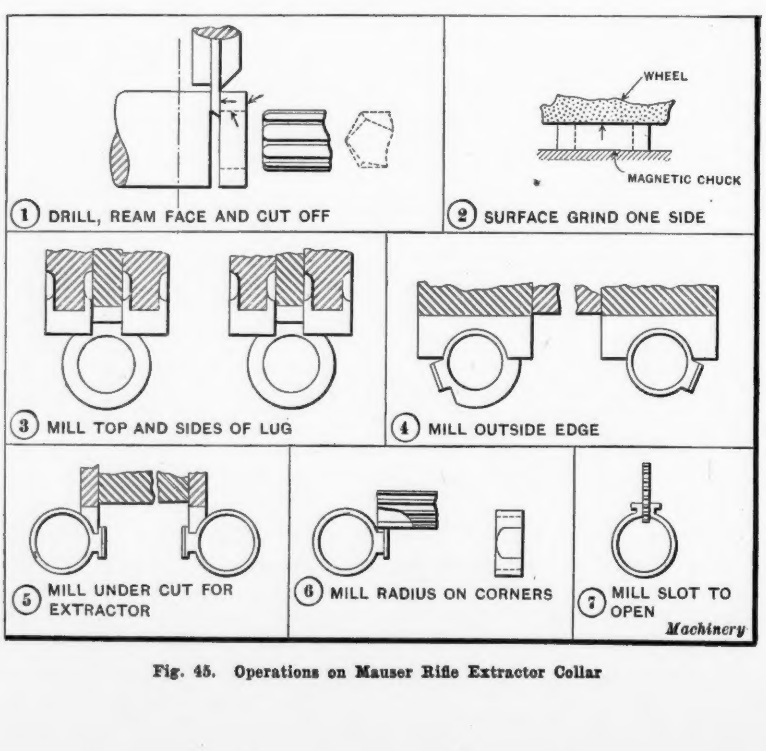
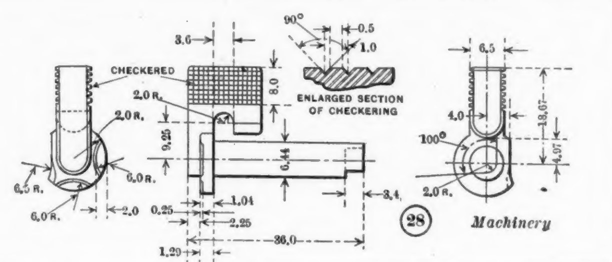


Fig. 45. Operations on Mauser Rifle Extractor Collar

TABLE XXIII. OPERATIONS ON SAFETY LOCK—PART NO. 28



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-lb. drop-hammer. Trimming press	Forging dies Trimming punch and die	..	..	60	1
2	Anneal and pickle	Anneal. furn. Pickling bath	......	..	..	100	..
3	Hollow-mill stem, drill and mill clearance hole and face shoulder	Five-spindle drill. mach.	Spec. jig	25-60	Hand	25	1
4	Mill right- and left-hand sides of thumb piece, boss and top, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.040	60	2
5	Mill right- and left-hand sides of thumb piece, boss and top, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.020	60	2
6	Straddle-mill front and rear ends of thumb piece	Lincoln type mill. mach.	Spec. vise; holds two pieces	50	0.040	70	2
7	Sweep-mill radius on rear end of thumb piece	Hand mill. mach.	Spec. rotary fixt.	60	Hand	60	1
8	Mill cam on end of stem	Hand mill. mach.	Spec. rotary fixt.	60	Hand	60	1
9	Spline-mill radius on thumb piece	P. & W. spline mill. mach.	Spec. fixt. Spec. cutters	60	0.005	35	2
10	Mill cocking-piece cam on flange	Hand mill. mach.	Spec. fixt. Former cam	60	Hand	100	1
11	Mill locking steps in rear of flange	One-spindle sensitive drill. mach.	Spec. jig Spec. cutter	60	Hand	70	1
12	Mill serrations in right- and left-hand sides of thumb piece, first setting	Hand mill. mach.	Spec. vise Spec. hob	50	Hand	80	1
13	Mill serrations in right- and left-hand sides of thumb piece, second setting	Hand mill. mach.	Spec. vise Spec. hob	50	Hand	80	1
14	Stamp	Bench work	Stamps	..	..	250	1
15	File corners and burr	Bench work	Files	..	..	50	1
16	Harden and temper	Hard. furn. Temp. bath	......	..	..	175	1
17	Polish	Polishing lathe	Leather covered wheels	4500	..	30	1
18	Blue	Niter bath	Wire basket	..	..	175	1

ing bushings. Two pieces are held in the vise jaws at one time.

Operation 7: Sweep-mill Radius on Rear End of Thumb Piece.—This is done on a hand milling machine, provided with a special rotary fixture, the fixture having two stops for locating the terminus of the radius and for milling the sides which is done by traversing the table longitudinally.

Operation 8: Mill Cam on End of Stem.—This operation is accomplished on a hand milling machine, using a special type of rotary fixture for holding the work. The fixture is provided with stops as in the previous case, to locate the terminal points when starting and stopping the radius cut.

Operation 9: Spline-mill Radius on Thumb Piece.—This is accomplished on a Pratt & Whitney spline milling machine, using a special fixture for holding one piece at a time. The cutters are set so that one feeds in, in advance of the other and then retreats while the other feeds in and passes the center.

Operation 10: Mill Cocking-piece Cam on Flange.—This operation is accomplished on a hand milling machine, using a special fixture for holding the work, and having a cam for controlling the movement of the cutter-spindle.

Operation 11: Mill Locking Steps in Rear of Flange.—This is accomplished on a single-spindle upright drilling machine, using an end-milling cutter which is guided by two bushings in the jig.

Operation 12: Mill Serrations in Right- and Left-hand Sides of Thumb Piece, First Setting.—This operation is accomplished on a Lincoln type milling machine, using a special vise that holds two pieces. The serrations on both sides are milled longitudinally of the stem.

Operation 13: Mill Serrations in Right- and Left-hand Sides of Thumb Piece, Second Setting.—This operation is accomplished in a similar manner to Operation 12, with the exception that the serrations do not run clear across the work, requiring a stop on the table of the machine.

Operation 14: Stamp.—This is a hand operation.

Operation 15: File Corners and Burr.—This operation consists in removing all the sharp corners from the thumb piece.

Operation 16: Harden and Temper.—See "Harden" and "Temper."

Operation 17: Polish.—See "Polish."

Operation 18: Blue.—See "Blue—Niter Bath Process."

The machining operations and other data on: the magazine and trigger guard, with components; various parts used in connection with the stock, such as butt plate, bands, etc.; and all other parts not treated in this number, including the stock and hand guard, will be described in the May number.

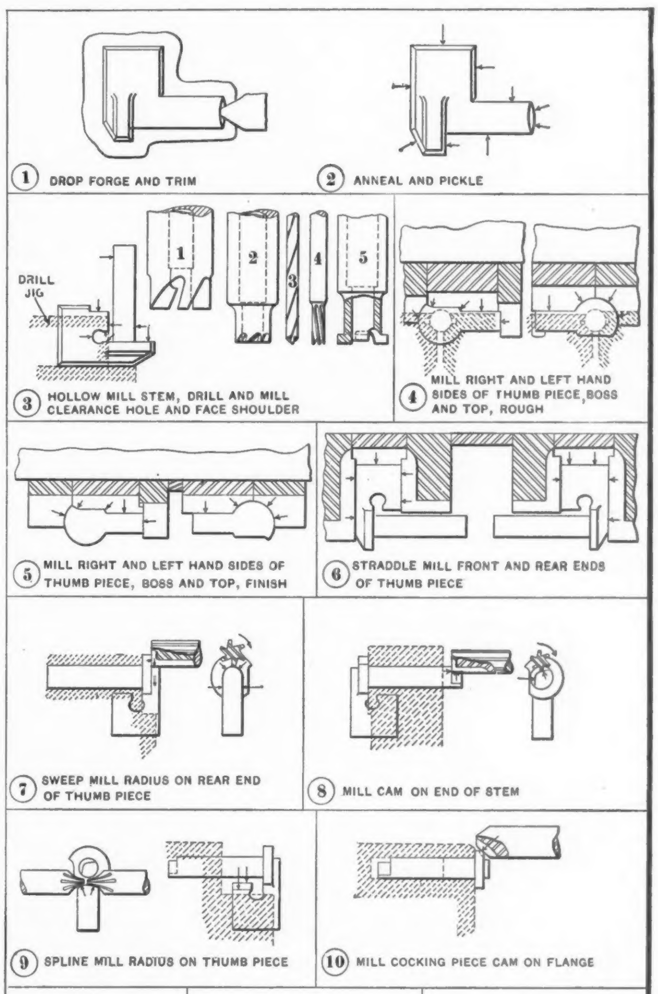


Fig. 46. Operations on Mauser Rifle Safety Lock

Entered at the Post-Office in New York City as Second Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY

140-148 LAFAYETTE STREET, NEW YORK

51-52 Chancery Lane
London, England

Cable Addresses
Machinery, New York
Machtool, London

THE INDUSTRIAL PRESS
PUBLISHERS

ALEXANDER LUCHARS
PRESIDENT

MATTHEW J. O'NEILL
GENERAL MANAGER

ROBERT B. LUCHARS
SECRETARY

FRED E. ROGERS
EDITOR

ASSOCIATE EDITORS
ERIK OBERG
FRANKLIN D. JONES
DOUGLAS T. HAMILTON
CHESTER L. LUCAS
EDWARD K. HAMMOND
VICTOR BROOK

APRIL, 1916

NET CIRCULATION FOR MARCH, 1916, 22,139 COPIES

Yearly subscription—$2.00; coated paper, $2.50; Foreign edition, $3.00. The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

MANUFACTURE OF MILITARY RIFLES

The articles on the military rifle begun in this number are unique in the annals of technical journalism. They specify step by step the operations employed in the manufacture of the Spanish Mauser rifle, which is conceded to be one of the simplest and best military arms used by the nations of the world. The American Springfield rifle is virtually a copy of the Mauser with certain modifications and improvements worked out by United States Army officers.

This is the first time that any journal has undertaken to publish a detailed description of the complicated and special methods by which the barrel, receiver, bolt and other parts are manufactured. Probably no other product is as exacting in the requirements of manufacture as the military rifle. It has to be accurately made of high-grade materials and in complicated and irregular shapes that defy description without the use of many drawings. The impulse of an ordinary mechanical expert on first examining a typical military arm is to say that many of the shapes and parts are finical and unnecessary, that other shapes would work just as well, that many operations could be eliminated, and that the arm generally represents the ideas of military officers to whom expense counts for nothing. But after analyzing the Spanish Mauser arm, we were much impressed to find that practically every shape is required, and that every part has a useful function.

With the possibility of this nation becoming involved in war at some not distant time, and finding it necessary to manufacture millions of army rifles, we feel that the publication of this article is serving a patriotic purpose. It takes out of the possession of a few and puts before thousands of readers, the knowledge of methods and tools employed by the most up-to-date armories. Besides making public these data, the articles will serve to indicate the extent of the task that any manufacturer undertakes when he starts to manufacture military arms on contract.

* * *

SHUTTING OUT IDEAS

One of the surest ways for a manufacturing concern to fall behind in mechanical progress is to keep a closed shop to all visitors. Any concern that develops original ideas and keeps abreast of the times must be constantly in touch with all developments which affect its methods or product. By closing the plant to outsiders, its own representatives must expect a similar lack of courtesy when traveling, and must necessarily be restricted in the interchange of knowledge mutually beneficial. The concern that strives to confine all ideas and novel developments within its walls generally succeeds in shutting out new ideas.

A large arms manufacturing plant, noted for its conservatism, which for many years has consistently excluded engineers and others familiar with manufacturing methods, was recently obliged to call in new blood to revise its methods and bring its manufacturing practice up to date. This experience is not unusual with unprogressive concerns, but it seems strange for a concern with a reputation for ingenuity and highly developed manufacturing practice. These changes were not necessary because of the lack of ingenuity among the men responsible for the shop methods, but because those men were so restricted in their contact with the outside mechanical world that they could not take advantage of improvements made in parallel lines of work. The habit of conservatism had become so fixed with them that it prevented them from mixing freely with other mechanical men, and from giving and taking ideas which would have been mutually helpful. A policy which produces this effect is a detriment to any concern, no matter how large and strong it may be financially.

* * *

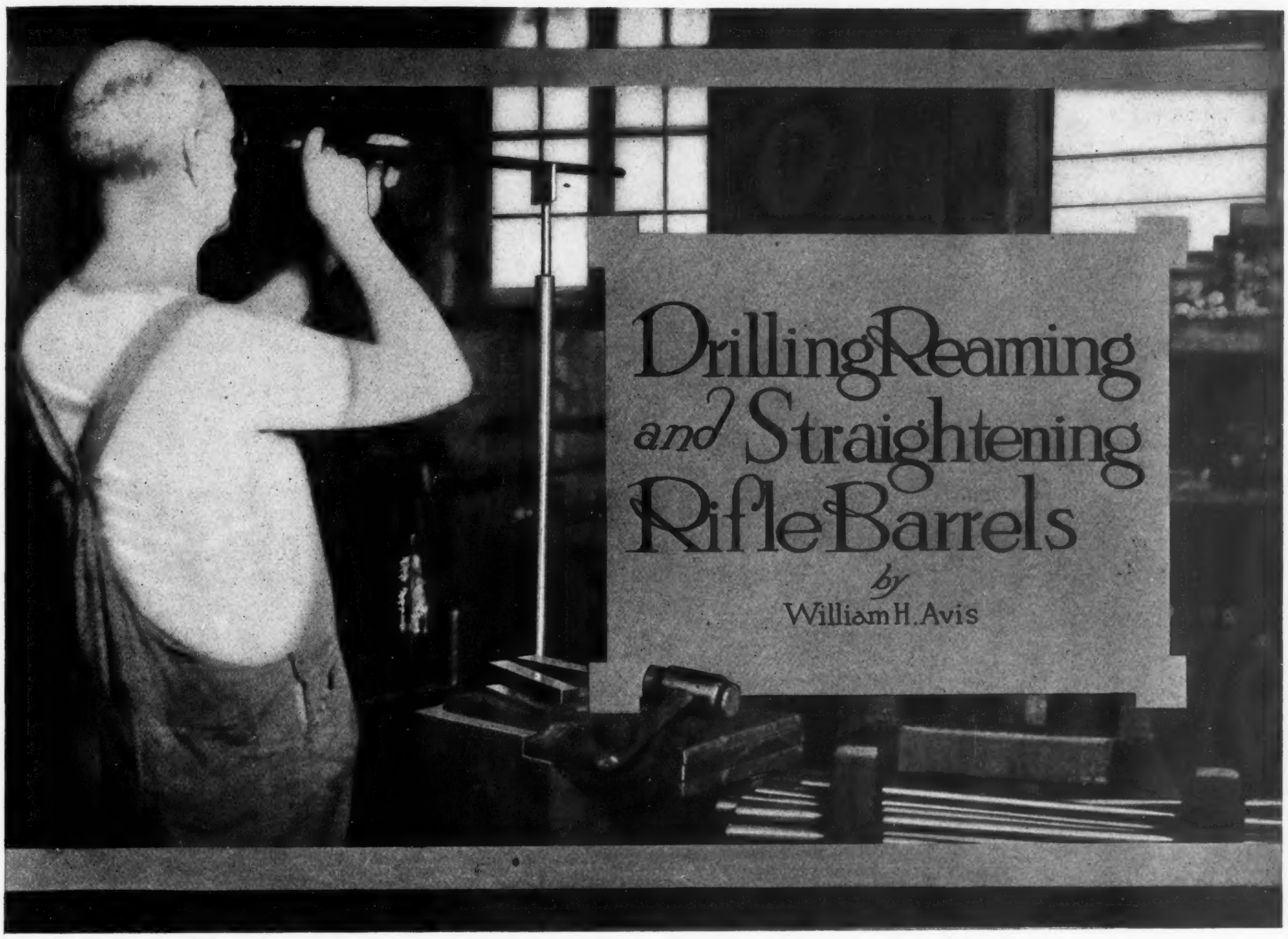
MATHEMATICS IN THE TOOL-ROOM

The value of clearly understanding the underlying principles of simple mathematics and trigonometry is not always evident to the toolmaker. He often relies on makeshift or graphical methods to get out of a difficulty when any question involving a mathematical calculation comes up. The cut-and-try process seems to the average toolmaker the only practical way of solving any problem that varies slightly from the ordinary run of tool work. He will spend hours arranging buttons to find the position of certain holes which could be quickly determined by a simple mathematical calculation and direct measurement.

An instance of this was recently brought to our attention. A toolmaker was given the job of laying out a multiple punch and die for blanking and cupping six blanks located diagonally in the strip, at one stroke of the press. The problem was to find the width of strip stock required to punch out six blanks economically. From experience this toolmaker knew that to get the greatest number of blanks from a given area the holes or circles should be laid out diagonally, and he set out to find their positions. Not realizing that they could be determined mathematically, he tried to find them by the button method, setting five buttons in a group having diameters equal to the blank plus the web. This took over a day, as the position of each hole had to be determined progressively; but a few minutes would have sufficed had he known that the distances of the holes from two given lines at right angles could be determined by finding the sides and bases of a series of right-angle triangles.

Where the work is laid out in the designing department and all essential dimensions given on drawings it is not so necessary that the toolmaker have a knowledge of mathematics as it is when he has to lay out the work for himself as he goes along. Many toolmakers point to this fact, stating that a knowledge of mathematics is useless to them. They overlook the inspiring fact that a toolmaker who has a knowledge of mathematics is unlikely to remain a toolmaker always, because his knowledge fits him for higher positions which he could not satisfactorily fill without it. Practical experience is absolutely necessary, but when coupled with a good technical education it is far more valuable to the possessor.

Lack of appreciation of technical journals and books which contain solutions of problems that come up every day in the tool-room is one of the reasons that many toolmakers lack the rudimentary knowledge of mathematics necessary to the successful prosecution of their work. A man who is looking out for his future should study as he goes along and read articles on the problems connected with his daily work.



RIFLE making experts in general concede that the most difficult part of a rifle to make is the barrel. A rifle with a barrel which is untrue is worthless; hence, the greatest care in manufacture is necessary in order to insure that this portion be as nearly correct as it is possible to make it. Should the interior of a barrel be out of alignment, the rifle would be unreliable and could not be depended upon to give accurate results under all conditions.

It can readily be seen from the foregoing that gun barrel making is a business in itself. As a matter of fact, there are factories where only gun barrels are manufactured and where no other gun parts are made, although there are no factories making other gun parts (except sights) exclusively. All the important operations on the barrel are carried on in the barrel department, although some of the minor opperations are performed in other parts of the factory. The operations done in the barrel department are: cutting off the stock, outside straightening, centering, drilling, spotting, turning, reaming, straightening, grinding, finish-reaming, rifling, etc. All these operations are important and must be done correctly or else the barrel will never "make." Threading, sight-seat milling, slot-cutting, rifling, polishing, browning, and other operations, as well as proving under powder tests, are done in departments not connected with the barrel department proper.

Credit is due to Frederick Kutcher, manager of the American Gun Barrel Mfg. Co., New Haven, Conn., for many of the photographs and much of the data that has been herein incorporated. This company is the only firm in this country now making gun and rifle barrels exclusively.

Rifle Barrel Material

While rifle barrels were formerly made of mild steel exclusively, the modern military rifle barrel is made of a much tougher grade of steel, owing to the more exacting requirements of the modern powders as contrasted with the strength needed when only black powder was used as an explosive. Thus the nickel steel barrel has come to the front and no modern military rifle barrels are made of mild steel at present. The stock from which the barrels are made usually comes to the factory in long bars which vary in length and diameter according to the style of barrel to be manufactured. The general specifications for rifle barrel steel at the present day are: carbon 0.50; manganese, 1.00; silicon, 0.30; phosphorus under 0.015; sulphur, under 0.015.

Cutting off Stock

The first operation to which the bars are subjected is cutting off, the bars being placed two or three at a time in a cutting-off machine which is supplied with a gang of circular saws. Fig. 1 shows an arrangement for cutting off rifle barrels to their proper length, due allowance being made on the length to provide for errors that may be made in machining. This is a multiple saw of the Higley type, having blades 12½ inches in diameter and 9/32 inch thick. The bars are clamped in place and are fed directly against the teeth of the revolving saws, the feed of the work being ⅝ inch per minute and the speed of the blades 10 R. P. M., which is equivalent to a cutting speed of 32 feet per minute. By means of a pump, a stream of oil is constantly directed onto the saws while the cutting operation is in progress, thus keeping them properly lubricated during the cutting-off operation. It is possible to arrange the saws so that barrels of various lengths can be cut off at the same time. A gang of eleven saws can be easily tended by one man with a helper.

Upsetting the Stock

After the stock has been cut into the proper lengths for barrels, it is upset at the breech end in order to bring it to the correct shape, after which it is ready for annealing. Two methods are used in upsetting the stock, *viz.*, forging in a regular

Author's address: Whitneyville, New Haven, Conn.

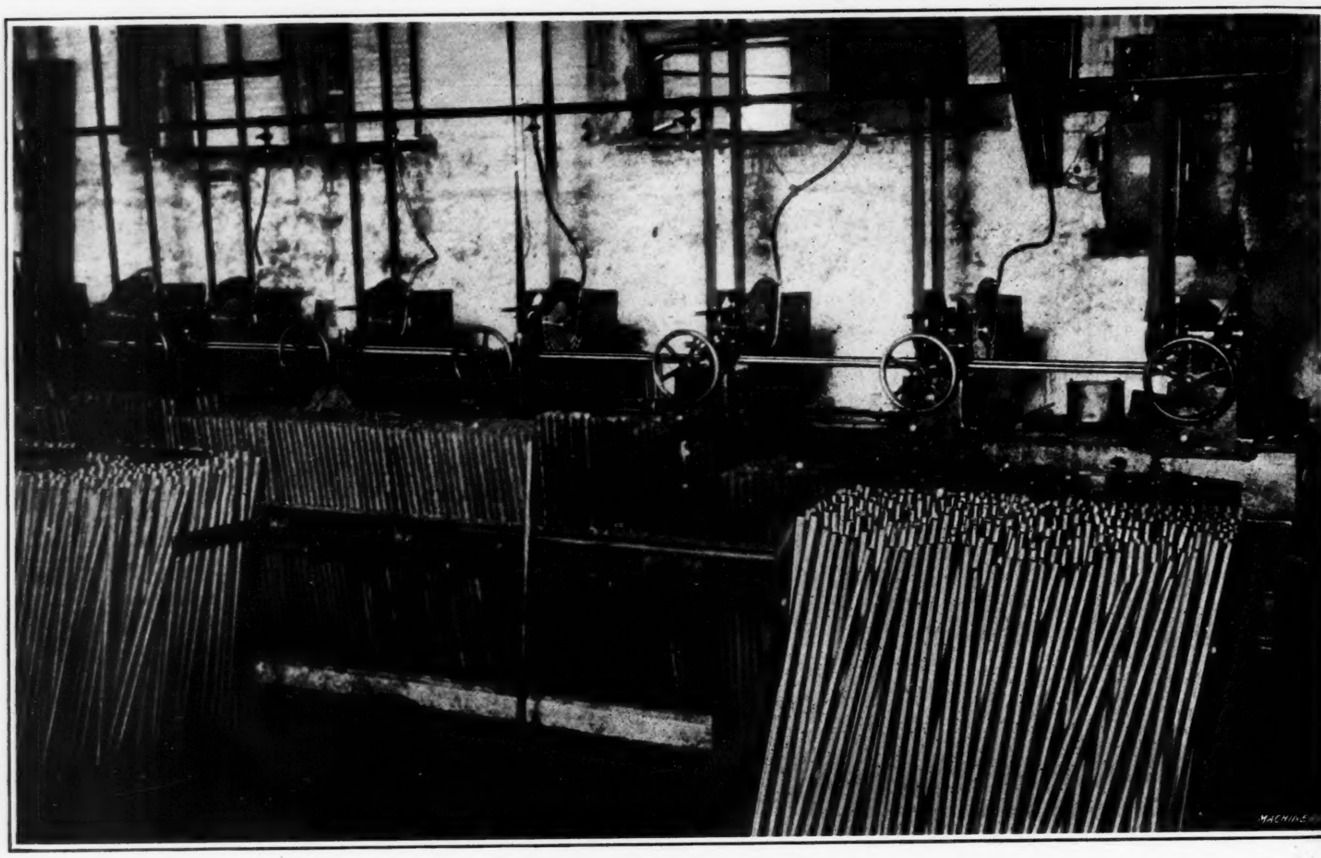


Fig. 1. Cutting off Stock for Rifle Barrels

forging machine and a process of rolling. In the factories where the barrel lengths are forged, the ram of the machine thickens and forms the butt of the barrel while the barrel is held lengthwise between two split dies. When the barrels are shaped by rolling, a pair of rolls is employed, these rolls having about six sets of various sized grooves, which are deep at the beginning and diminish as they progress around the rolls. As the deep cavity of the first groove in the roll comes around to the operator, he thrusts the end of the barrel stock into it and partially shapes it. By following this procedure with each set of grooves successively, the barrel is finally brought to its proper shape.

Annealing Barrels

After the barrels have been upset they are taken to the annealing furnace, where they are slowly heated to the critical temperature, which is dependent on the grade of steel being treated. They are then removed, packed in lime and allowed to cool slowly.

Outside Straightening

Before the barrels are sent to the drilling machines, they are looked over by a workman and any that are crooked on the outside are straightened by him. This process is called "outside straightening," and while it is important, it does not necessarily require an expert workman, as anyone of ordinary intelligence can learn to do it in a short time. If the straightening were improperly done and the barrels went to the drilling machines in a crooked condition, the result would be that the drills, in passing through the stock, would come out at one side instead of in the center, or that the walls of the barrel would be thick in some places and thin in others. Either of these conditions might result in disaster when the barrel was turned down to its proper size and shape in the turning lathe. In other words, a barrel which is not properly straightened on the outside might not "make" in the subsequent operations.

Butt Turning

After annealing, the barrels are taken to the butt turning machine as indicated in Fig. 2. In this operation, the barrel is placed through the spindle of a shaving machine and the butt end held in a split chuck while the end is turned down and made ready for the drilling operations. Some factories also center the butt end in order that the drill may enter the stock directly in the center when the drilling operation is started, while in other factories no centering is done.

Drilling Rifle Barrels

The drilling of a rifle barrel is an especially important operation for the reason that if a barrel is not properly drilled, it almost invariably finds its way to the scrap heap. In order, then, that this may not happen, it is absolutely necessary that the drills used be perfect, both as to gage and cutting capacity. The man who keeps the drills in proper condition, although he may not operate the machine, is called the "driller," and he must be a man having more than ordinary skill and intelligence. Highly skilled drillers who keep the drills in first-class condition are difficult to find.

Two types of drilling machines—horizontal and vertical—are in use today. One of the larger companies uses a vertical drilling press for barrel drilling, which was, perhaps, until recently, the most perfect press of its kind, and which is manufactured at the factory where it is used. These drilling machines have several secret attachments connected with them not found on other styles of drill presses. One of these attachments is a motor contrivance by which the drills can be speeded up from 1300 revolutions per minute to 3000 without necessitating a change of belting. When drilling nickel steel barrels, or 0.45 carbon steel, the speed at which the drills are run is about 1760 revolutions. For soft steel barrels, however, the highest speed obtained is about 3000 revolutions. The time necessary for drilling a high-grade steel barrel is from forty-five to sixty-five minutes, while the maximum speed at which soft steel barrels are turned out is about twenty minutes, according to the length of the barrel.

Under the drill presses at this factory, in the basement, an immense oil system is located, consisting of a series of reservoirs holding many hundreds of gallons of oil which is forced by pumps of high pressure through the whole drilling system. The pumps connected with this oil system develop pressure of 800 pounds or more, by which the oil is kept in constant circulation, passing through each drill and finally back to the great central reservoir in the basement. The drill chips which come from the center of the barrel are automatically carried out by the flow of oil and deposited in receptacles which are connected with the drilling system.

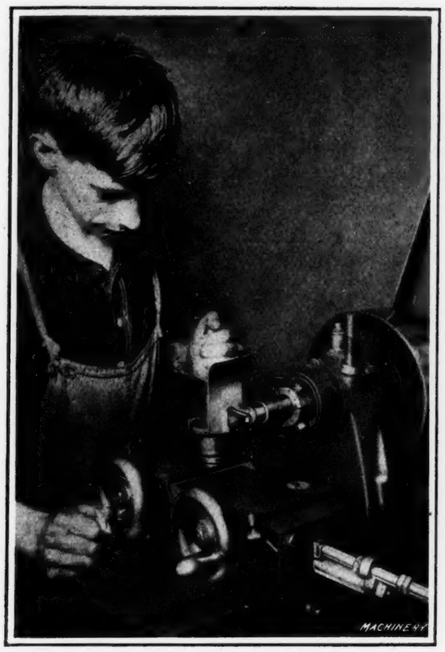


Fig. 2. Butt Turning Breech End of Barrel on Shaving Machine

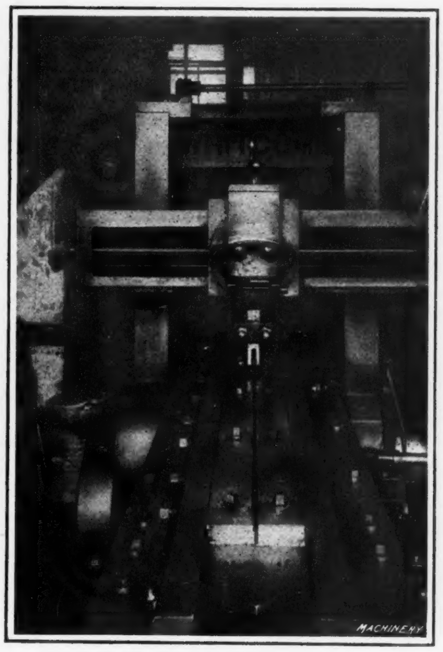


Fig. 3. Rolling in Drill Shank Groove on Planer with Special Fixture

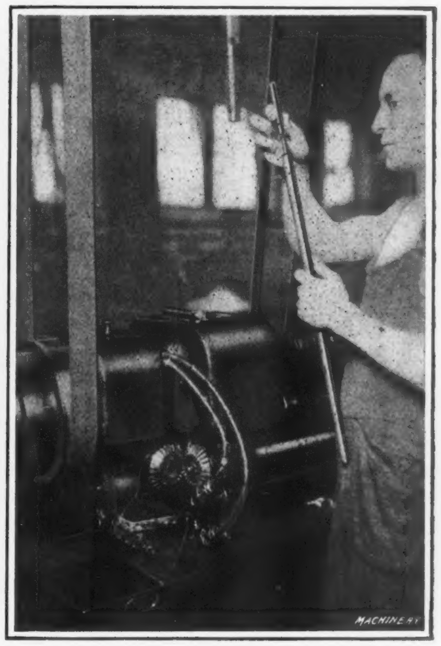


Fig. 4. Gaging Accuracy of Gun Barrel after Reaming

Gun barrel drilling is a difficult operation on account of the extreme length of the hole as compared with the diameter of the drill and also because of the toughness of the steel in which the drilling must be done. In either horizontal or vertical drilling machines, the barrels are revolved and the drills held stationary. The vertical machines are a more recent development and are considered to have several advantages over the horizontal types, such as reduced floor space and better removal of chips. The horizontal type of machines is best known and will therefore be described here. Fig. 5 shows a Pratt & Whitney gun barrel drilling machine, while Fig. 6 shows a closer view of the work on the machine.

On this type of machine, two barrels are drilled simultaneously, there being two spindles, each of which is driven independently from an overhead belt. Beneath the spindles are worm-gears that carry motion to the lead-screws outside the two walls of the machine. These lead-screws can be seen in Fig. 6, and from each of these screws the corresponding carriage is operated. The feed of the carriages may be engaged or disengaged by hand-levers, and the disengagement is also automatically effected by a set of stops, as shown in Fig. 5. The rate of speed on a gun barrel drill depends on the quality of the steel which is being drilled. The barrels are usually drilled at a speed of about 1760 revolutions, as previously mentioned, and the rate of feed is about one inch per minute, which is about the maximum rate. The method of driving the barrel is by a contact on the muzzle end against the center of the spindle, while the other end is supported in a bushing as indicated in Fig. 6. The pump pressure, by means of which the oil is circulated through the drill when drilling, is of great importance, as this pressure must be sufficient to work out the chips along the passage provided for them so that they will not clog or cause other trouble. The shank of the drill rod is securely fastened in the chuck on the drill carriage at the end of the machine, while the tip or cutting end of the drill passes through a bushing at the center of the machine.

Shape of Drills

The shape of the drills used at the shops of the American Gun Barrel Mfg. Co. is the same as that used by other large manufacturing concerns. The shank to which the drill tip is brazed is the same shape as the drill, that is, half round, with a deep groove running from one end to the other, and having a crescent shaped hole which passes completely through the shank and drill tip. The method by which the groove in the shank is obtained is by placing the shank, which is a round thin-walled tube, in a special fixture and rolling in the groove under the pressure of a revolving wheel as shown in the illustration Fig. 3. This roll is forced down on the tube as the planer bed travels, thus compressing the metal and forcing it to take the form shown. The method of obtaining the crescent shaped hole in the drill tip is not the same as that employed on the shank. This tip is from 3½ to 4 inches in length and is made of the best grade of high-speed steel. It is drilled through the center in its rough state before it is shaped up, the hole extending from end to end. The tip is then placed in a die and drop-forged to produce the groove from end to end in the tip. The displacement of the metal caused by forging in the groove causes the round hole to become crescent shaped. The tip is then shaped up and brazed to the end of the shank, after which the cutting end is ground to its proper shape by the operator. The method of forming the end of the drill tip and its tube is shown in Fig. 7, which represents a filing jig, in which the shank and tip are filed to correspond to the angular surfaces on the jig.

In grinding the drill tip, the practice varies somewhat in different factories, some claiming that the drill should be ground slightly below center so as to drill (as it is called) "for a wire," while others believe in grinding the drill tip on center in the usual manner. When drilling "for a wire," a slender thread of steel is left at the center of the barrel, and when the end of the drilling is reached a disk like that shown at *A* in Fig. 8 drops out. Care should be taken in the amount of feed used on the drill so that the chips may come out in such a way that they will be readily carried out through the groove in the drill shank without any tendency to clog. It is much better to have the chips like those shown at *B* in the illustration, which are fine and can be reduced to powder between the fingers, than to have them long as shown at *C*, for the reason mentioned. Medium grade oil is generally used in drilling barrels, although some manufacturers use a high grade of oil. It has been found, however, that the medium grade answers the purpose just as well as the higher quality and it is stated by some manufacturers that even better results are obtained by its use.

To obtain the best results in drilling rifle barrels, either of the military or sporting type, the very best judgment is necessary. When the drills are over-speeded or crowded, the result is a barrel defaced with drill rings and gouges from one end to the other. In addition, the operations which follow the drilling are retarded by attempts to save the barrels from the scrap heap. Judgment must therefore be used so that the drilling machines are manipulated in such a way as to produce the greatest amount of good work possible without over-speeding.

Varying Qualities of Steel

The quality of steel used in rifle barrels has a far-reaching effect on the drilling processes, and brands of steel which may

have been perfectly satisfactory at one time are often the cause of trouble at others. Single lots delivered at factories sometimes contain such variable qualities of steel that the greatest difficulty is experienced in working the stock up into barrels. Thus, in some shipments, part of the stock will run good while other portions will create trouble from the cutting-off process to the finished article. Soft and hard spots will be found in the stock and the drilling is therefore much handicapped, while the other processes such as straightening, reaming, grinding, etc., are also interfered with. In the working up of such stock, an inferior article is likely to be produced on account of the variable conditions under which the work is manufactured.

Reaming the Barrels

The first reaming operation usually comes just after drilling, but this is not always so, as some factories turn the barrel both before and after reaming. The tendency today is to do away with as many operations as possible and at the same time obtain the best results. Instead of using a medium or low grade of oil in the reaming operations, the highest grade of lard oil is used. The steel used for the reamers varies, a very excellent grade for this purpose being the "Gold Label Styrian" brand. The reamers used in this operation are fluted, and at the works of the American Gun Barrel Mfg. Co. a double reamer has been used with remarkable success. This reamer removes as much in one cut as was formerly taken in two. The construction of the reamer is such that it is smaller near the shank than it is at the other end, the part toward the shank being so proportioned that it will remove about 0.005 inch at one cut, while the second or finishing section removes 0.002 inch.

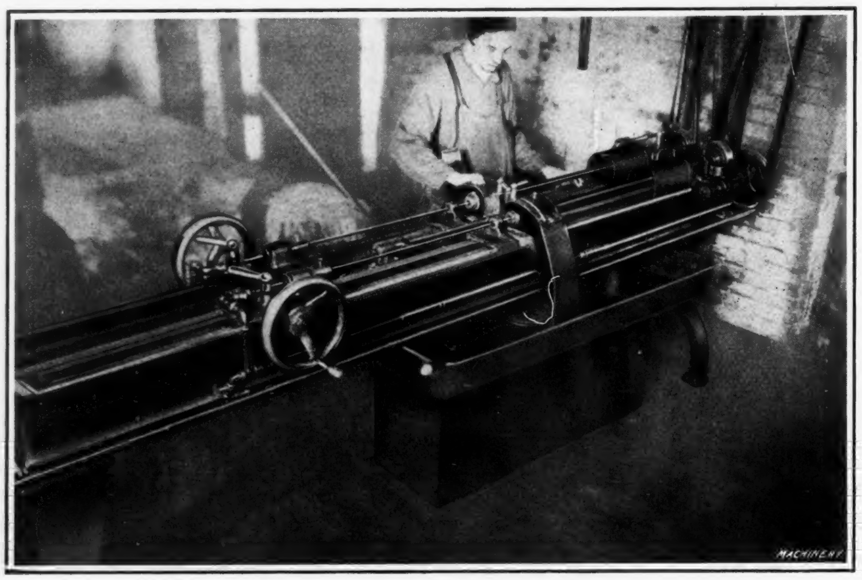


Fig. 5. Pratt & Whitney Gun Barrel Drilling Machine

An illustration of a Pratt & Whitney gun barrel reaming machine is shown in Fig. 9. An enlarged view is shown in Fig. 10. The reamers are pulled through the work instead of pushed, as in drilling. The cutting edges of the first section of a double reamer are notched at regular intervals in order that the stock which is cut out of the barrel will not clog the cutting edges and cause the tube to "ring." "Ringing" a barrel means that under certain conditions a reamer, drill or boring tool cuts a deep circular hole below the otherwise level inside surface, thus causing a serious defect. The first section of a double fluted reamer contains only one-half the cutting edges of the second half. Reamers are not hollow like drills, and instead of the oil passing through the center of the reamer, it flows through the reamer shank into the barrel. The reamers do not revolve at the high rate of speed at which the barrels revolve while being drilled, but the operation of reaming is performed much quicker than that of drilling, because the feed is greater. Six Pratt & Whitney reaming machines will take care of the output of ten drilling machines. Each reaming machine holds two barrels, and one man is required to run from two to three machines, while two men can run ten drilling machines.

The general construction of the Pratt & Whitney reaming machine will be understood by referring to Figs. 9 and 10. The drive is by a single pulley through gearing and a lead-screw, and a worm and bevel gears drive the two feed-rods. From these feed-rods the carriages are driven by bevel pinions and thrown out of gear by means of adjustable dogs. The head end of the machine is shown in Fig. 9 and reveals the bevel gears mentioned, together with some of the other details. In reaming, the barrels are clamped in the center of a long oil pan shown in the illustration, and are held by the butts while the reamer shanks are run through the barrels by sliding the carriages which contain the oil pans toward the head of the machine. The reamers are then fastened on the ends of the shank and the oil-pan slide is run back until the cutting edges of the reamer come in contact with the barrels, after which the machine is started. The reaming speed for 0.303 caliber is about 200 R. P. M., and the feed is about 4 inches a minute. As a general thing, the roughing reamer has four flutes, while the finishing reamer has six. It is very important to keep the reamers in first-class condition if good work is expected, and the services of a skilled mechanic are therefore required for this purpose. Close watch is required and the leeway allowed on finish-reaming is very small. An error of 0.00025 inch is sometimes sufficient to send the barrel to the scrap heap, providing the hole is that amount too large. The final or finish-reaming operation is done by practically the same method as that just described. Closer work and more skillful workmanship, however, are required on the finishing cuts than on the first cut, inasmuch as practically no leeway is allowed. On the finish cut all interior imperfections must be removed and the inside walls of the barrel must be made as clean and bright as the polished surface of a looking-glass, lest the keen-eyed inspector may discern some slight defect which would cause rejection of the barrel. Fig. 11 shows a group of drills and reamers used in the operations just described.

Reaming Gages

The gages used for the reaming operation are round and have a very slight taper. They are marked at intervals by fine lines which completely encircle them, and which indicate fractional parts of a thousandth of an inch. On account of the closeness of the work demanded, these gages are changed from time to time, and in the larger and more important small-arms factories, they are taken up weekly in order to discover and remedy any inaccuracies. The manner in which the reaming gage is used is clearly indicated in Fig. 4, which shows an operator testing the accuracy of a barrel that has just been reamed.

Forming and Turning Barrels

After the reaming operation, the barrels are taken to a turning lathe where they are spotted in the center preparatory to putting them on the barrel turning lathe. "Spotting" means that a cut is taken in the center of the barrel about 1 inch in length and to the diameter to which the outside of the barrel is to be first turned. The center-rests on the barrel turning lathe are brought up against this spotted center while the turning processes are in progress. The operation of spotting is clearly shown in Fig. 12. In turning the barrel after the spotting operation, the butt end is held by a dog while the muzzle is fitted to a center plug and the rest at the center of the barrel steadies it as indicated in Fig. 13. The two tool carriages, each of which carries a cutting tool, are now adjusted and each tool is started at the same time on the barrel, one at the muzzle and the other at the spotted center portion. The tool carriages feed toward the butt end of the barrel and remove about one-eighth inch

of stock during the turning operation. Over each cutting tool, a flexible hose is adjusted, through which a stream of soda water and oil is directed onto the cutting edge of the tool, lubricating and cooling it at the same time. Another stream of lubricant plays on the muzzle as it revolves on the center. Automatic adjustable knock-offs are provided so that when the two tools have reached the limit of the cut the feeds are knocked off.

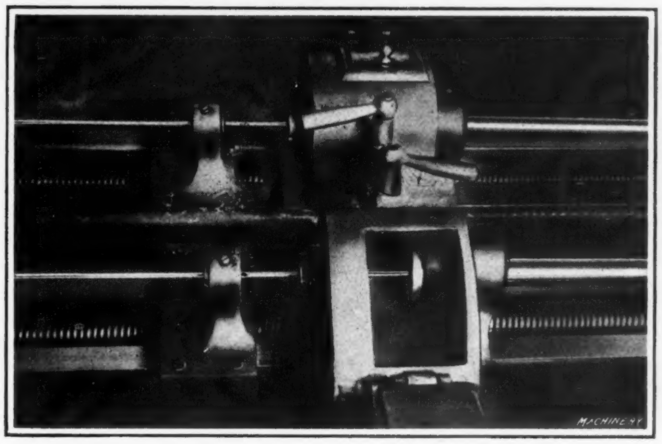


Fig. 6. Enlarged View of Drilling Machine showing Carriages

Forming Barrels

All rifle barrels are not of the same shape although military barrels of today are very similar. Thus in barrel turning, the turning lathe is equipped with formers of various shapes which conform in outline to the shape of the barrel to be turned. Fig. 14 shows a group of these forming plates, which are adjusted at the back of the lathe in such a manner as to act as guides for the tool carriage. In the majority of cases, the lathes used in these forming operations are equipped with two carriages as mentioned, although in some factories four or more cutting tools are used in order to increase the production as far as possible. The operation of turning and forming the barrels is clearly shown in Fig. 13, this illustration being obtained at the works of the American Gun Barrel Mfg. Co.

As a general thing, about one-eighth inch is taken off from a barrel at one cut and about fifteen minutes is the average

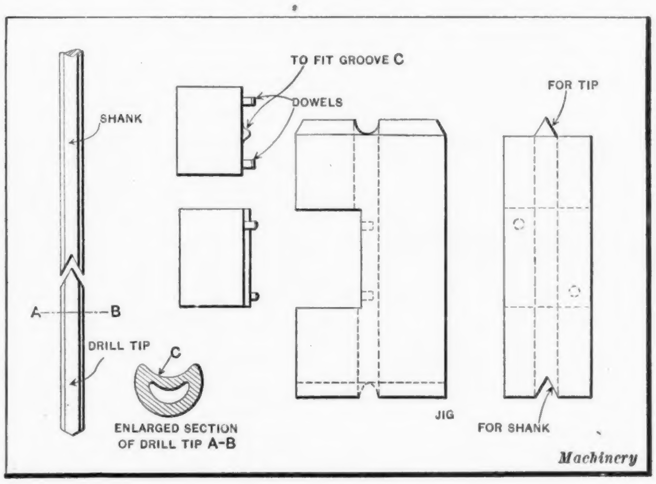


Fig. 7. Jig for filing Drill Tip and Shank

time required for turning. It must be understood that nice work is required in this operation, as the exterior surface of the barrel must be put in the best condition possible for the grinding operation. Grooves of any depth are not permissible and the turned surface must not show roughness to any extent. The cutting lubricant used for the turning and forming operation is generally a composition of soda water. The "Acme" compound (Cataract Refining & Mfg. Co.) is used by the American Gun Barrel Mfg. Co. as a turning lubricant. The speed of turning varies from 450 to 500 revolutions per minute and the rate of feed is about one inch per minute. It is of the greatest importance that the cutting tools used in turning should be very sharp, for there is nothing that will crook a rifle barrel more easily than dull cutting tools. Oftentimes the barrels are sprung through the use of dull cutting tools, so that when the barrel straightener has made the inside of the barrel straight and true, it is found that the outside is badly crooked and entirely out of shape.

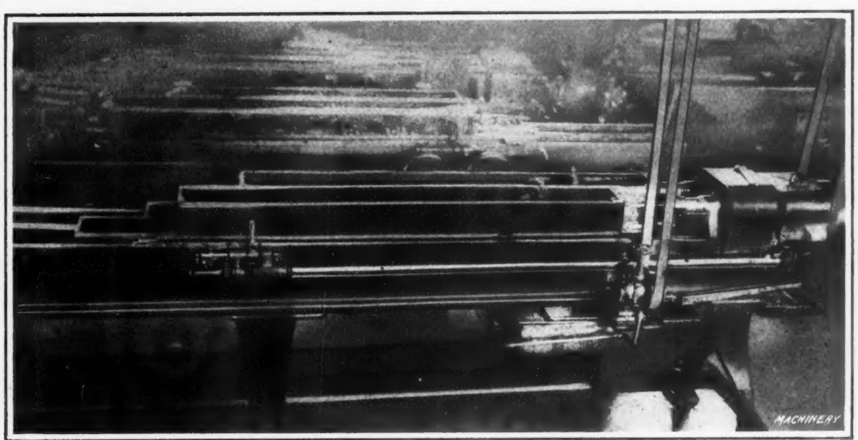


Fig. 9. Pratt & Whitney Reaming Machine

Straightening Barrels

The straightening of the barrels is conceded to require the greatest skill of any operation in the manufacture of rifle barrels. As the writer of this article has spent nearly a third of a century in the occupation of straightening barrels, and

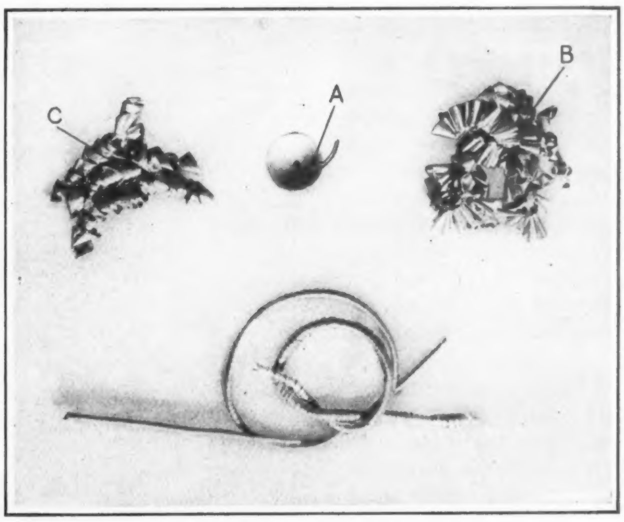


Fig. 8. Samples of Turning and Drilling Chips and Disk A removed when "drilling for a wire"

as there has probably never been a comprehensive article written on this subject before, the operation will be treated exhaustively here in the hope that a real understanding of the method of rifle barrel straightening may be conveyed to the minds of the readers.

The first requirement for a rifle barrel straightener is the keenest and most perfect eyesight; in fact there must be positively no defect of any kind in the eye. One of the most peculiar features in connection with this is that no one knows whether or not his eyesight is sufficiently perfect for this line of work until he has tried to straighten rifle barrels. Young men who have supposed their eyesight to be perfect and who have never suffered from eye trouble of any kind, have endeavored to learn the art of rifle barrel straightening and have found that within a short time their sight has greatly deteriorated, so that they have been obliged to withdraw from the work in order to preserve their eyesight.

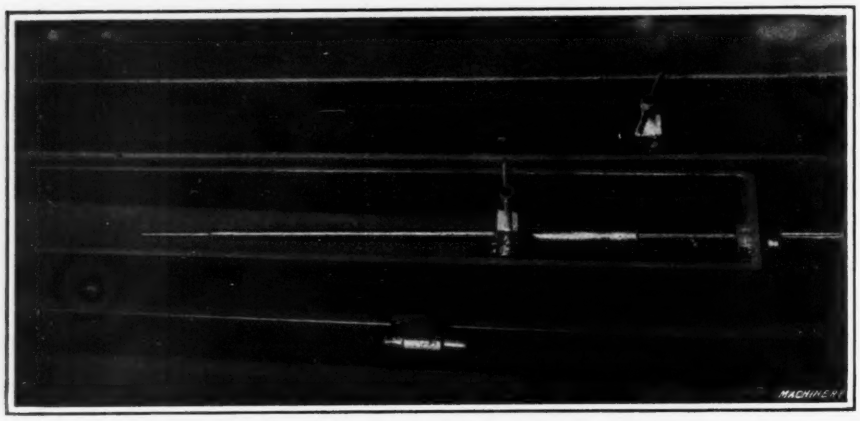


Fig. 10. Enlarged View of Reaming Machine shown in Fig. 9

It is not generally known that but one eye is trained in the art of barrel straightening, but in the writer's long experience as a straightener, he has met but one person who could straighten barrels by using either eye. To the average straightener, the inside of a rifle barrel looks as strange to his untrained eye as it does to a man who is not a straightener, and in order to straighten barrels by using the untrained eye, time would be required in which to train it to do the work. Despite the fact that only one eye is used in the straightening process, the barrel straightener never squints either eye but views the interior of the barrel with his trained eye while both eyes are wide open. It is amusing to a barrel straightener to see a person squint one eye in order to look through a rifle barrel. In connection with the straightening of rifle barrels, it should be said that there is no one living who can tell by the glance of an eye through the interior of a rifle barrel, whether or not the barrel is true so well as a straightener. The barrel straightener also learns by constant practice and training just how much can or cannot be done to a barrel.

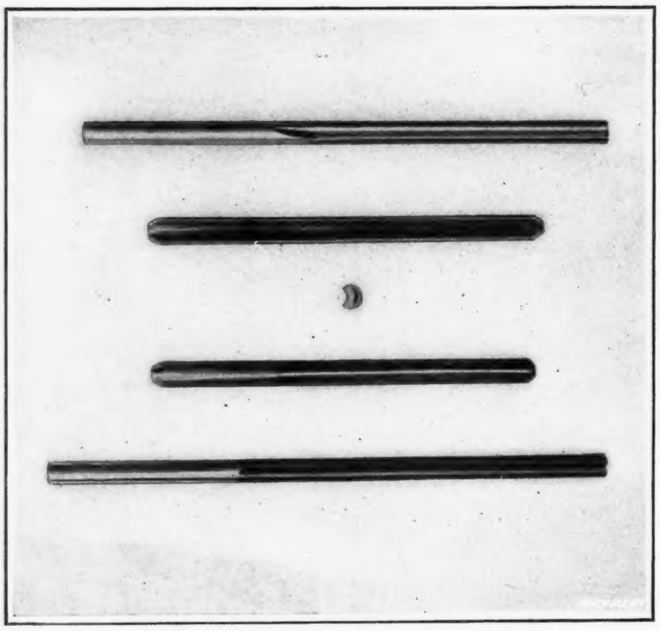


Fig. 11. Gun Barrel Drills and Reamers

In straightening a rifle barrel, the three important tools required are a shade, a straightening block and a hammer. The best light possible must be provided in order to produce the best results. Straightening shades should be placed in windows having northern exposure which insures a steady light all day long and eliminates those shadows that fall across the shade from surrounding objects when other exposures are used. The heading illustration of this article shows an ideal arrangement for rifle barrel straightening, in which the window shade consists of a ground glass window pane, one-half the size of a window, and fitted into the upper half of the sash. Across this ground glass pane, about in the center, a stick is fixed horizontally. This stick varies in thickness according to the distance of the straightening block from the shade. Thus, if the block is located a considerable distance from the shade a heavier stick is used than if the block is near the shade. At a distance of about twenty feet, the stick would be one-half inch in thickness in order to produce the necessary shade result in the barrel, as it is the shadow or shadows cast by this stick on each side of the interior of the barrel which indicate to the straightener whether or not the surface of the barrel is true and straight. Sometimes two sticks are fixed across a shade, one heavier than the other. This is in order that a heavy or a fine shadow may be used, according to the preference of the straightener. This is shown on the shade in the heading illustration.

The shadows on the inside of the barrel are two thin, dark lines, one on each side of the interior surface of the barrel and slightly below the center of the bore as indicated in Fig. 15 at *B*. These lines extend from the ends of the barrel nearest the shade to and slightly beyond the center, after which the shadows diffuse somewhat. To one unfamiliar with the interior of a barrel, the lines appear to extend back from the ends of the barrel only an inch or two, and practice is necessary in order to familiarize the eye with their appearance. Now if these lines run straight, as shown at *B*, it indicates that the end of the barrel where they are located is straight. However, should they diverge from a straight line and zigzag in various directions as the barrel is revolved by hand, as shown at *A*, it indicates that there are crooks in the barrel. When the appearance of these lines is anything but straight, the straightener is obliged to use his skill in overcoming the defects, and when the shadows are finally made to run straight on one end of the barrel the other end can be treated in like manner. When the shadows run straight on both ends, the barrel may be considered as being straight from one end to the other in its entire length.

The straightening block shown in Fig. 16 consists of a heavy base on which are fastened two narrow steel dies which converge at the left side of the operator. These dies are about 1½ inch in width and of hardened steel, in order to withstand the severe service to which they are put. The object of locating them in vee form is in order that the spot in the barrel where a long crook is indicated by the shadows, may be so placed that it will come about right on the dies. The reason for this is that the barrel must be straightened for a long distance when a long crook is encountered, and for only a short distance when the crook is short and sharp. The barrel is placed on these dies, while it is struck directly between them at a spot nearest the center where the first crook is located. The hammers used in straightening average about 5½ pounds in weight and are of mallet shape. Those used for rough-straightening, prior to the turning operation but after drilling, are of steel, while those used

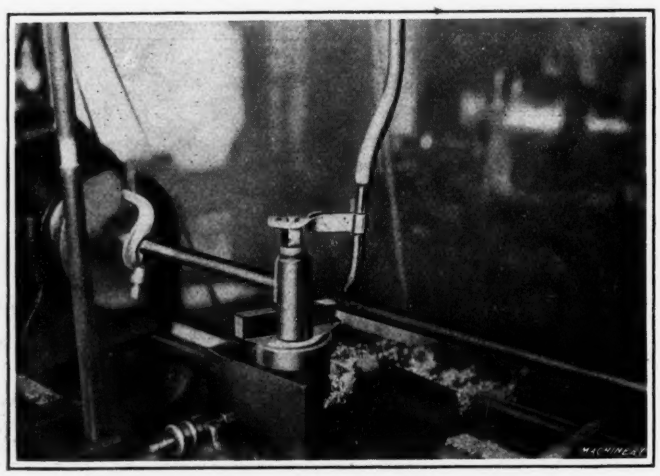


Fig. 12. Spotting Center of Barrel before Turning

after turning are of copper or babbitt. The copper hammers are to be preferred, because of their greater durability and also on account of the greater sensitiveness which the copper hammer gives, permitting the straightener to gage his blow to a nicety. In straightening a barrel, if it is struck at just the right place and with just the proper weight of blow, the crooks will be eliminated and the straightener can go ahead to the next defect, working always away from the center of the barrel toward the end.

It is absolutely necessary that the middle crook be eliminated before the next one can be operated upon successfully. In other words, each crook must be gotten out in its turn, beginning at the center of the barrel and working toward the end farthest from the operator. There are several methods of shading by means of which barrels are straightened, but the method which this article describes is one which is recognized as being the most advanced.* The shadows in a crooked barrel approach each other from each side of the interior of the barrel in places and diverge in other places. The point at which the shadows approach each other, is the proper place for the hammer blow to be struck, directly between the lines. If the blow falls just right, the line will spread and run true at that point, which will indicate that that particular crook has been eliminated. A little further on in the barrel, it will probably be found that the lines diverge or recede from each other, and it is important that the barrel should never be struck at this spot, for a blow between the diverging lines would cause them to diverge still more, which would mean that the crook would be intensified. By spinning the barrel around between the hands in the upright rest which is fixed as shown in the heading illustration, it will be found that directly opposite the place where the lines diverge they approach each other. Thus we have the same condition under which the first crook was eliminated, and a blow directed between the lines at this point, if properly struck, will also cause the lines to spread here, so that the second crook will be overcome.

This same method is followed to the end of the barrel and when all these crooks have been removed and the shadows run straight from the center to the end of the barrel, the other end may be operated upon.

Those who are not barrel straighteners are frequently fooled by the appearance of the shadows in the interior of rifle barrels when the surface is uneven. In this case they do not run straight, but

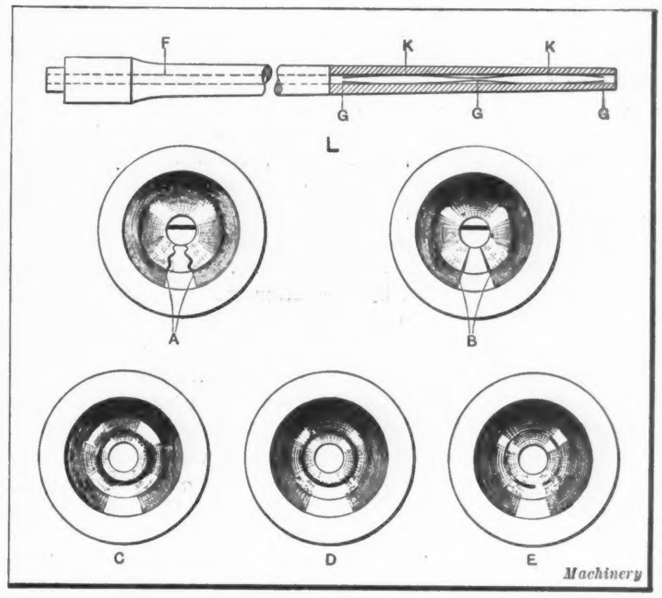


Fig. 15. Diagrams showing Appearance of Defects in Rifle Barrels

in some places apparently run out of a straight line. No matter how the barrel may be turned and moved, this condition remains the same. In other words, the shadows look the same all around the interior surface of the barrel. The skilled straightener knows just what this indicates and he is also aware of the fact that all the pounding in the world cannot improve such a barrel in the least, for only reaming can eliminate this crooked appearance of the lines. In a case of this kind, if there should be enough stock in the barrel to permit a perfect leveling and smoothing up of the surface by means of reaming, it would be found that the lines would assume a straight and true appearance. This matter of uneven surface of the interior of a rifle barrel is one of the most unsatisfactory problems with which the barrel straightener has to contend, as the inspector who is not a barrel straightener himself, decides that the barrel is crooked on account of its appearance, and therefore sends it to the straightener to be straightened, when in reality it should have been returned to the reamer.

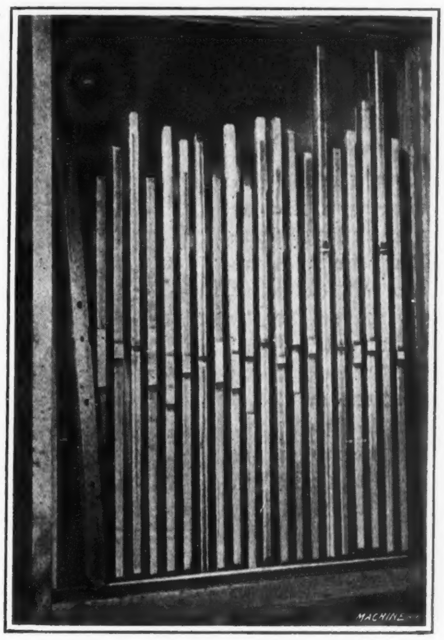


Fig. 14. Forming Plates used for Barrel Shapes

The difficulties of rifle barrel straightening vary with the caliber of the barrel and the quality of the steel used in its manufacture, the soft steel barrels being much easier to handle than those of the harder steel, such as 0.45 carbon or the regular nickel steel. The smaller the caliber of a barrel, the more difficult it is to straighten, and when small caliber and nickel steel are combined, then, indeed, the straightener has his hands full in getting out a satisfactory day's work. Perhaps there never was a more difficult barrel to straighten than the 0.23 caliber, nickel steel, Lee barrel which was made for the U. S. Navy at the time of the Spanish-American war. Added to the natural difficulties was the government inspection which was exceedingly rigid and severe. There are few military rifles, however, now used by any government in which the caliber is smaller than 0.30.

Straightening Machines

Before proceeding with a description of the hand straightening operations, it may be advisable to state here that in some gun concerns, principally abroad, straightening machines are used instead of the hammer and block. The writer has tried this method and can testify that excellent work can be done with the machine, but it is not nearly as fast as the hammer and block method. The impression prevails in some quarters

* The concentric ring method of observation in straightening rifle barrels is used in the Springfield Armory and abroad with very good results.—Editor.

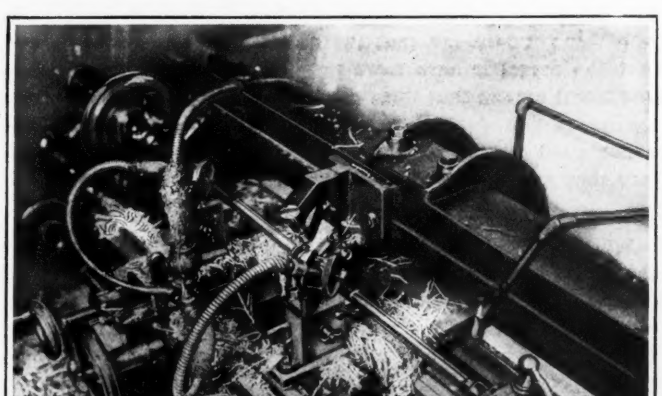


Fig. 13. Turning and forming Barrel

that anyone can run one of these machines and straighten rifle barrels with it, but this opinion is erroneous in the extreme, inasmuch as no one but a rifle barrel straightener can use such a machine, and while good work can be done in this way just as good work can be done and is being done every day with the block and hammer, it is doubtful if quite as difficult straightening can be done on a machine as with the hammer and block. It is admitted by those who use both methods that machine straightening is not nearly as economical as hammer and block straightening, and that one man can do fully as much work by the latter method as three can do on a machine. Machine straightening for shot gun barrels has proved more satisfactory than it has for rifle barrels, inasmuch as the former are much thinner and therefore can be bent more easily. Sharp, deep crooks in nickel steel barrels cannot be removed with any degree of swiftness by a machine and not nearly as satisfactorily as with a hammer and block. That fine work can be done on machines on barrels containing moderate crooks, however, is admitted by all experienced straighteners who have used them.

When barrels are straightened with a steel hammer after such operations as turning and grinding, hammer marks are invariably left on the interior, these being finally removed by reaming. When a barrel has been properly straightened on the inside, the outside should conform and be perfectly true and straight unless the turning has been improperly done. In order to discover whether or not the barrel is straight on the outside after it has been finished on the inside, it is placed in the centering machine and spun rapidly with the hand. If true and straight, the barrel will run true, but if the barrel should wobble during this test, it is evident that the outside is not true, and if very bad it is rejected and scrapped.

Defects in Rifle Barrels

Many times the interior surface of a barrel is marked by a ring caused either by the drill or reamer wearing a circular hole in the surface. Sometimes the defects are slight, while at other times they are very pronounced. When the rings are slight, a reamer cut will generally clean them out, but when too deep to be eliminated by reaming they are "set in" by the straightener in such a way that the final reaming will remove every trace of the defects. "Setting in" a ring means that the straightener locates the exact spot of the ring, and by hammering completely around the barrel at that spot while the barrel rests directly on the die, he raises the ring above the level of the interior surface so that when the reamer cut is taken only the raised surface containing the ring is cut out and the defect is thus removed.

The straightener soon learns the difference between a reamer ring *E*, a drill ring *D*, and a powder swell *C*, shown in Fig. 15. The reamer ring is invariably a succession of nicks or gouges which completely encircle the interior surface of the barrel at the spot where they are located. On the other hand, the circular cut of a drill is likely to be clean, deep and startlingly pronounced. A powder swell is indicated by the "downhill" like appearance of its nearer and farther edges which dip gradually to its extreme depth directly in its center. The edges of the swell are always smooth and the general appearance of the swell itself is smooth. This powder swell is produced during the testing of a rifle barrel, and is really a failure of the barrel to stand the strain of the test. The "proof-test" is always made before the barrel is rifled and the powder charge is much heavier than that used in regular service.

One of the greatest difficulties with which the straightener has to contend is the variation in some of the stock from which rifle barrels are made. In places the stock is found to be hard, while in other places soft spots occur. The result is that the straightener gages his blow on a crook as he judges it should be, but in the event that there is a soft spot at that particular place in the barrel, the blow is too heavy, with the result that the barrel is made more crooked than ever. A condition of this kind always results in much hammering that could have been avoided had the operator known of the soft spot beforehand. On the other hand, when a hard spot is encountered, no damage is done, as the blow is not heavy enough to cause the barrel to assume a more crooked shape. Hence, the crook is not disturbed and the next time a harder blow is struck which may be just hard enough to make the crook disappear. There is no way of discovering this irregularity of stock until the hammer falls upon the imperfect spot.

The upper diagram *L* in Fig. 15 represents a barrel with one-half perfectly true, as indicated by the dotted lines at *F*, and the other half with crooks at *K*, which are shown somewhat exaggerated in the sectional view. When straightening crooks, the barrel must always be struck at intermediate points such as *G*, but never at points *K*, as this would intensify the defect.

Final Straightening

The straightening thus far described is done on barrels between the various operations mentioned and a steel flat face or nearly flat face hammer is used. It is the straightening between the operations mentioned which is most likely to crook the barrel, and which takes place before the barrels reach the chambering or rifling stage in the manufacture. It is generally considered that there are no operations hard enough to crook barrels after they have passed beyond the grinding stage, but it has been found that barrels are crooked at times even after they are rifled and that because of thus being crooked, they fail to shoot as accurately as they should. Such barrels have, as a general thing, also passed the browning operation, and in handling they must not be bruised in the least either externally or internally, so that it is an exceedingly difficult thing to straighten the barrels under these conditions; yet a skillful straightener can put them in first-class condition even when they have reached this stage.

Fig. 16. Straightening Rifle Barrel

Such barrels are straightened on copper dies, a rawhide or copper hammer being employed. The barrels are wrapped in paper which is glued in several layers around but not to the barrel itself. The blow of the rawhide hammer on the paper leaves no mark on the barrel, either inside or outside, nor do the copper dies bruise the barrel, so that when carefully done it is found that the defect has been overcome and that the barrel is once more in good condition. The opinion is general among first-class straighteners that all rifle barrels should be looked over in their finished state and that those which need retouching should be attended to in this way before they are sent away from the factory to the market.

Grinding Barrels

When the barrels have been properly straightened, after the finish-turning, they are sent to the grindstone to be ground, and after the grinding operation they are reamed again, after which they are ready for the finish-straightening. If properly ground, the straightener has simply to touch them up and correct any slight imperfections that may be found. They are then sent to the finish-reaming machine which cuts the interior surface to the exact size required before the barrels are sent to the rifling machine. Two methods are now in use for grinding the barrels. One is that in which large stones of great weight are employed and the other is by means of automatic grinding machines. Each of these methods has

its advantages, but there is no doubt that barrels can be ground more expeditiously on the large stones than on the smaller ones of the grinding machines, especially when the grinder using the large stone is an expert at his work. When this is not the case, however, the barrels may be badly crooked both externally and internally, which makes it necessary for the straightener to do considerable work in order to bring them back to condition once more, and at the same time makes much work for the filers in filing out unnecessary hammer marks and other defects on the outside surface of the barrel.

The grindstones generally used in the operation of grinding rifle barrels are from five to six feet in diameter and from twelve to fourteen inches face width and weigh from 3500 pounds to two tons each. They are swung on an iron frame of great strength, and when in operation revolve at about 185 R. P. M. Fig. 17 shows an operator engaged in grinding a rifle barrel, using a steel rod passed through the bore of the barrel from the butt toward the muzzle. The butt end of the rod tapers which causes the rod to grip the barrel at this point. The rod is equipped with a handle on which a hollow wooden grip is fixed. This handle is grasped by the operator who places the barrel in a shoe set parallel with the horizontal axis of the grindstone and distant an inch or so from the face. The grinder now presses the long lever with his hip, which forces the shoe toward the face of the stone by means of a toggle action, and as the barrel touches the stone, the grinder turns the handle of the rod on which the barrel is held so that it is revolved against the face of the

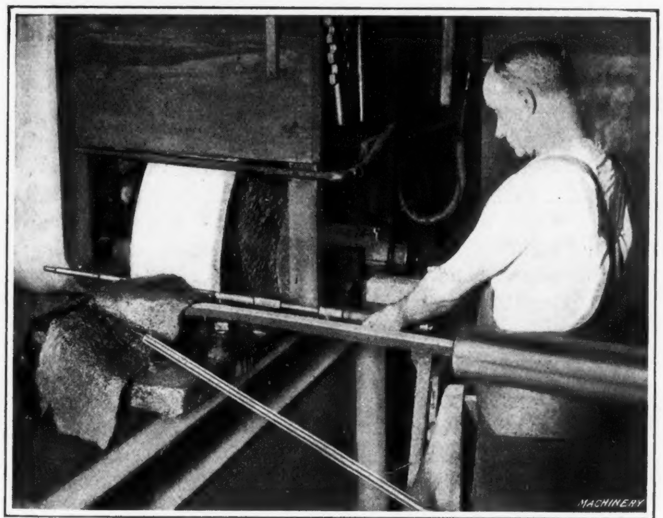


Fig. 17. Grinding Outside of Rifle Barrel

stone in the opposite direction to that in which the stone is revolving. The barrel is always ground from the center toward the butt, then from the butt toward the muzzle, working it across the face of the stone until it has been ground for its entire length. During this operation, a steady stream of water plays on the surface of the stone, which prevents the barrel from burning, and also prevents the stone from glazing. Furthermore, the water makes the stone cut faster by acting as a lubricant.

Grinding the exterior surface of rifle barrels removes all the defects and imperfections left by the turning process as well as the hammer marks caused by the various straightening operations which have preceded the grinding. An expert rifle barrel grinder has acquired through long experience a sense of touch which tells him the amount of pressure necessary to use in bringing the barrel into contact with the stone. A careless grinder, however, may press the barrel too hard against the stone and thereby cause it to buckle and bend. The average amount of stock removed from the barrel during the grinding operation is about 0.010 inch. A snap gage and gaging board are used to determine the proper size for a barrel when finish-ground, the barrel being laid on the gage board and gaged at the butt, middle and muzzle. After the barrels have been ground to their proper size, they are washed in limewater to prevent rusting.

As the face of a grindstone wears down, hard pebbles are often encountered embedded in the surface of the stone; unless these are removed, trouble is likely to be caused by these stones marking the outside surface of the barrel. As soon as a pebble is discovered, the stone is stopped and the pebble cut out by the grinder, using a cold chisel and hammer in the operation.

Military rifle barrels may be made either with or without forged front sight lugs. In some factories, muzzle sight lugs are brazed on the barrel just before the finish-reaming operations, between finish-reaming and finish-straightening. There is a difference of opinion as to which method is the better, as the brazing on of these lugs is likely to crook the barrel, thus making it more difficult to straighten in the final straightening operation. The writer is in favor of the latter method, however, inasmuch as the barrel is in better shape to straighten at the muzzle through all the first operations when the muzzle is free of a sight lug than when the lug is forged on. The hardest part of the straightening is always found in the early operations on rifle barrels, and many times crooks are met with directly under the forged lug which are almost impossible to eradicate because the lug is in the way. When, however, the brazing of the lugs takes place just before finish-straightening, the crooks are much easier to knock out than if they have been encountered during the earlier operations.

Inspection before Rifling

After the rifle barrels have been finish-reamed, they are subjected to the final inspection for reaming and straightening, consisting of the following operations: interior gaging, leading, shading and surface inspection. The gaging operation is for the purpose of determining whether or not the bore of the barrel is true to the size required, as the slightest variation one way or the other may mean the rejection of a barrel, especially if it is over size. If under size, however, it is sent back to the finish reamer who reams it to the exact size. The leading operation is done by pushing a lead bullet through the barrel by hand, a brass rod being used for this purpose. In the slow passage through the barrel, the bullet which fits the bore snugly must not meet with any obstruction from one end to the other. Should there be any resistance, even the slightest, the barrel is rejected and returned to the finish reamer who removes the imperfection. Just so is the barrel rejected in the shading operation, which determines whether or not the barrel is crooked or straight. When found to be crooked, it is up to the straightener to retouch and make the barrel straight. The slightest defect on the interior surface of the rifle barrel, such as rings, poor surface, gouges, scratches or markings of any kind whatsoever, which can be discerned with the naked eye, will cause its rejection and it will be returned to the finish reamer or straightener for corrections.

Rifling Barrels

After the barrels have passed the various inspections for workmanship successfully, they are passed along to the rifling machines where the grooves are cut which cause the bullet to rotate in its passage through the barrel. The number of grooves in rifle barrels varies from four to six or even seven in some instances. The twist also varies in different makes and models of barrels, some making a complete turn to every ten inches, and others requiring thirty-six inches in order to make a complete turn. The operation of rifling is done on specially constructed machines and will not be described in detail in this article.

Other Operations on Barrels

After the barrels have been rifled, they are again inspected and given a thorough leading in order to remove all rough edges and smooth down the grooves. In some factories the operation is done by means of tools worked by hand, while in other factories machines are used. Whether done by machine or hand, the operation is the same, as a lead slug which is cast to fit the bore of the barrel is worked back and forth through it, after it has been charged with fine emery and oil. After the leading operation, the chambering, threading,

slot-cutting and extractor-cut operations are done. In the chambering operation, five tools are used; a counterbore, two roughing reamers, a heading tool and a finish-reamer. A "Ball" speeder is then used to take out the burr at the beginning of the rifling grooves, beveling them to the right shape just where the bullet protrudes from the end of the barrel. In the finish-reaming operation on the chamber, the work is done by hand in some factories and on a chucking machine in others. The workmanship required in the cutting of the extractor slots must be exceptionally good because a fractional part of a thousandth of an inch out of the way may mean spoiling a barrel. Poor workmanship here would mean that the cartridge might not fit as it should in the chamber or that after the rifle had been discharged the shell could not be extracted.

The slot-cutting operation is sometimes done before rifling and the threading operation on the butt of the barrel is almost invariably done after rifling. The extractor cuts are made after chambering, and the sight studs are machined before rifling. Then comes the muzzle finishing, which is done partly by machine and partly by hand, the barrel being left longer in the rough state than is really necessary, in order that there may be no mistake in the final finishing.

Polishing Barrels

Military rifle barrels are polished on wheels which run at very high speeds, the larger wheels running at the rate of 3500 R. P. M., while the smaller ones attain an even higher speed than this. The wheels used for polishing have a wooden center and are covered with leather, the leather being coated with glue on which a heavy coating of emery is sprinkled. For rough polishing, No. 60 and 70 emery is used, and for finishing No. 90 is used. Plugs or handles made of metal are stuck into the muzzle and butt of the barrel when it is ready to be polished and fit snugly into the rifle grooves so that the barrel will not turn on the handles and injure the rifling. The handles spin in the hands of the operator at the same high rate of speed at which the barrel is spinning, but as these handles are very smooth the operator's hands are not injured by the friction. At one time the work of polishing was done exclusively by men, but at the present time women as well as men are employed in this part of the work. After the barrels are polished, they are ready for the browning operation, which is the final stage through which the barrel passes before it is assembled.

All military rifle barrels are subjected to a high powder test before, and a target test after, rifling. The first test varies according to the grade of steel in the barrel, high nickel steel barrels being tested with a powder charge which would burst a low-grade steel barrel. The test charge includes a heavy leaden slug, and the combination is from two to three times as heavy as the charge which would ordinarily be used in service. Should there be seams in the stock or other defects, the first test preceding the test after rifling, which is made with the regulation charge in order to determine the accuracy of the rifle, will bring them to light.

Browning Barrels

The final operation to which rifle barrels are subjected before they are ready for the assembling room is that of browning. While the finished barrel is blue in color and not brown, the operation is called "browning" because the barrels have to be rusted on the exterior surface before they can be blued. The coating of rust is obtained by covering the outside of the barrel with a browning mixture which causes it to rust after it has been baked in an oven heated by coil steam pipes. The air in the oven is moistened by perforated steam pipe through which the steam is allowed to escape into the oven. Before the rifle barrels are run into the hot oven for baking, they are subjected to a number of other operations, the first of which is wiping. In this operation the barrels are thoroughly wiped in order to relieve them of every particle of grease or other foreign substances and are then placed on circular iron trucks which are made to hold fifty barrels at a time. The truck and barrels are then placed in an upright caustic soda tank where they are boiled for about fifteen minutes. From this tank they are taken to another, where they are thoroughly rinsed so that every particle of grease and oil is removed and the barrels are ready for the spongers who apply the browning solution.

It is well to state here that the most successful rifle barrel browners have their own secret formulas which are jealously guarded so that only the browners themselves know the exact proportions of the mixtures. It is no unusual thing, therefore, to find barrel browners who have held their positions for many years, on the strength of their knowledge in this respect. One of the oldest and most satisfactory formulas for browning rifle barrels consists of the following mixture:

Spirits of wine	5 ounces
Spirits of niter	8 ounces
Tincture of steel	8 ounces
Corrosive sublimate	4 ounces
Blue vitriol	4 ounces
Water	1 gallon

The barrels are kept in the oven for four or five hours and when taken out are heavily coated with rust. They are then immersed in a third tank of chemicals for fifteen minutes, a secret formula often being used at this stage. A preparation which will give excellent results, however, is as follows:

Tincture of muriate of iron	1 ounce
Nitric ether	1 ounce
Sulphate of copper	4 scruples
Rain water	1 pint

If the process is to be hurried, two or three grains of oxymuriate of mercury can be added. When the barrel is finished, it is placed in limewater for a short time to neutralize any acid which may have penetrated. The barrels are now ready for carding, which is done on a 14-inch wheel having a face 3 inches wide covered with carding cloth. This wheel revolves at about 1600 R. P. M. and the man who does the carding stands at the back of the wheel and presses the barrel against the rim. After the barrels are carded they are returned to the spongers for a second coating of the browning solution. The operations of boiling and scratching on the carding wheel are continued until all the pores of the steel are thoroughly coated and their condition is satisfactory to the inspectors, who give them a most rigid examination. After using the scratch brush, the following formula can be used:

Shellac	1 ounce
Dragon's blood	25 ounces
Rectified spirit	1 quart

Or:

Nitric acid (specific gravity, 1.2)	1 part
Nitric ether	1 part
Alcohol	1 part
Muriate of iron	1 part

The above ingredients are mixed together, after which 2 parts of sulphate of copper and 10 parts of water are added.

After the barrels have been passed by the inspector, they are taken to the assembling room where they are assembled with the other parts. Many persons suppose that the browning of a barrel is done for the sake of appearance, and while this is partly the reason, the principal object is to preserve the barrel and prevent rusting. Were it not for the care taken in the browning operation, rifle barrels would not last nearly as long as they do.

* * *

ANALYSIS OF 1916 AUTOMOBILE ENGINE DESIGN

An analysis of motor car engine design made by *Motor* shows that 71.1 per cent of the 1916 model cars have the L-type of cylinder; 12.3 per cent, T head; 12.3 per cent, valves in the head; 4.4 per cent, sleeve valve or "Silent Knight" type. The cars are classified as 44.7 per cent four-cylinder; 41.1 per cent, six-cylinder; 11.6 per cent, eight-cylinder; and 2.6 per cent, twelve-cylinder. A higher revolution speed has been obtained either by using alloy pistons, which is being done only in comparatively few cases, or by reducing the thickness of the cast-iron pistons. The aluminum alloy piston introduced by a few concerns in their stock motors has worked out well. Connecting-rods have been lightened also by reducing the cross-section and by using stronger material. In some cases tubular connecting-rods are used.

SURFACE SCRAPING AND SURFACE PLATES

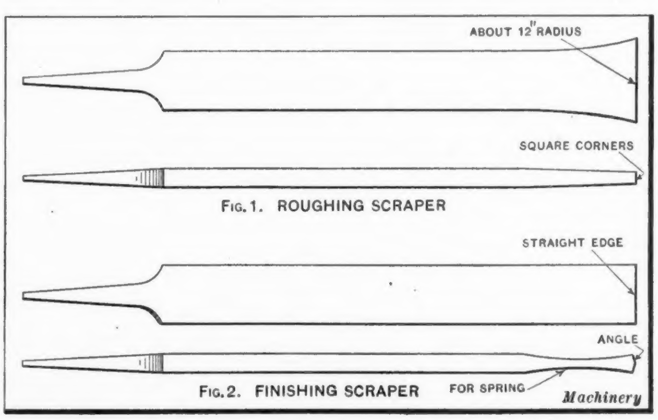
BY BRYAN T. HAWLEY*

The writer, who has worked in several shops with French, German and Swedish experts with the file and scraper, and who himself has had much experience in scraping machine parts, read the question and answer in regard to practice in surface scraping in the January number with much interest, and although the practice of scraping has been so generally eliminated by the use of precision machinery, grinding machines and American haste that it seems almost like a lost art, he will give the readers of MACHINERY the benefit of his experience and observation.

When the part to be surface scraped has been machined, it should be scraped once or twice all over before the color is applied. The common color compound is oil mixed with lampblack, Prussian blue or red lead. Lampblack mixed with lard oil and applied to the surface plate is used by patternmakers for woodworking mostly, but it is good also for marking metal surfaces for rough scraping. Prussian blue paste in tubes is smooth and convenient to use, but a small amount of lard oil mixed with the paste improves it. The Prussian blue mixed with oil should be applied to the surface plate and the high spots of the work are marked with the blue. Red lead mixed with mineral machine oil to the consistency of putty is the best mixture for all-around surface scraping and for fine spotting in particular. Lard oil can be used instead of mineral machine oil when the mixture is applied to the surface plate, but on account of its smeary nature it is undesirable to apply it to the work, on which a dull red lead surface is required which shows the high spots black and shiny when rubbed with the surface plate.

The mixing of red lead requires some patience, as the lead and oil do not unite readily, and considerable pounding, stirring and kneading are required. The mixture should be worked until it is smooth. When the compound is kept in a receptacle such as a hand soap can, it may be allowed to dry out some and then used like shoe or stove polish, mixing in as much machine oil as is required at the time.

For rough scraping, apply red lead generously to the surface with a rag, using machine oil as needed to assist in spreading. When an even coating has been spread, place the surface plate on the surface to be scraped, rub a little and remove. The high spots will be clearly defined by the red markings. This is the best way to show the bearing spots. When the spotting shows fairly uniform all over, the process should be reversed, applying the red lead and oil to the work in a somewhat drier form, with the object of attaining a dull red coating which, when rubbed with a clean surface plate, will make a good background for the polished black high spots. The amount of



Figs. 1 and 2. Unforged Roughing and Forged Finishing Scrapers made from Old Files

red lead should be gradually reduced and a little gasoline should be mixed with it to act as a drier, finally using just enough red lead to dull the surface without coloring it. This procedure will show the true high spots. They will be small, to be sure, but no false bearing will appear, which is likely to happen if the surface plate is kept colored.

There are many forms of scraping tools used. It is common practice to use old fourteen- or sixteen-inch flat files, simply ground as desired and stoned to edge. The accompanying illustrations Figs. 1 and 2 show side and edge views of an unforged roughing and a forged finishing scraper. Forging the finishing scraper is worth while if a forge is convenient. The main difference in the finishing scraper is that the cutting edge should be more obtuse, giving less clearance and less rake.

Surface plates are apparently costly when looked on as simple pieces of cast iron, but they are accessories well worth

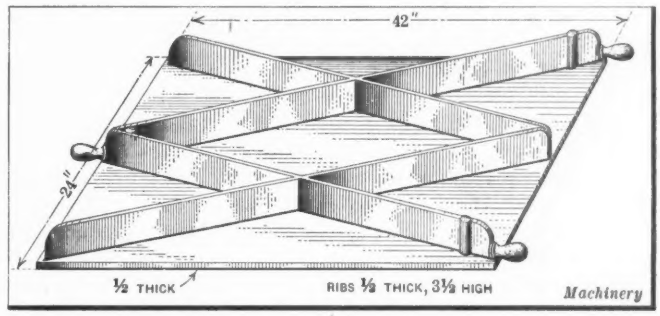


Fig. 3. Light Surface Plate with Ribbed Back

their cost in any up-to-date machine shop. Often machine parts are set up to be planed or shaped when the surfaces machined could be quickly filed and scraped at lower cost if a surface plate were available.

A long time is required to season cast iron to the state that will entirely eliminate warping, and even a well seasoned surface plate has to be scraped occasionally. It should be very thick and heavy, considering the area. Shops that have considerable use for surface plates will find it a good investment to make a pattern for a convenient size surface plate and have three castings made from it. With these three plates planed, a good mechanic can finish the surfaces of all true without the use of a master surface plate, and produce plates as accurate as can be supplied by any of the well-known makers of small tools and shop accessories. The home-made surface plates would have the advantage of having the size and weight best suited to the conditions in that shop, and they need be not more than one-fourth as heavy as a surface plate would necessarily be which could not be checked up often. A convenient surface plate is 24 inches wide by 42 inches long, ribbed on the back and provided with three handles, two on one end and one in the center at the other end, as shown in Fig. 3. Two men can handle this plate when necessary without tackle, its weight being about 200 pounds. This weight no doubt will seem very light to some mechanics, but as the writer has used surface plates of these proportions and weight with satisfaction for several years, he feels justified in recommending them to others. Surface plates should be made of close-grained gray iron and machined at least one month before scraping. Several months of seasoning will be required before they can be depended on for very accurate surfacing, but as long as three plates are used, they can always be resurfaced accurately. Following is the method employed for obtaining a truly flat surface on three plates without using a master plate:

Numbering the surface plates 1, 2 and 3, respectively, we scrape the three plates smooth, removing all tool markings; then put red lead on plates Nos. 1 and 2 and roughly scrape them together, with the object of eliminating all rocking. Now put red lead on plate No. 3 and roughly scrape it to fit plate No. 1. Plate No. 1 may be concave and plate No. 2 convex, and yet both rubbed together would show a good bearing, and plate No. 3 also may show a good bearing with plate No. 1. But plates Nos. 2 and 3 will be imperfect in opposite ways and to about the same extent. The next step is to scrape Nos. 2 and 3 together, taking off as nearly as possible the same amount of metal from each until a fairly good bearing is secured. Next scrape Nos. 1 and 2 together and 1 and 3 will be found imperfect to the same extent, but in opposite ways. Now scrape these together, taking the same amount off each, and follow this order of operations until a good bearing is shown on all.

* Address: 608 W. Brighton Ave., Syracuse, N. Y.

METAL CUTTING WITH OXY-ACETYLENE GAS*

A REVIEW OF PRACTICE OF CUTTING METALS WITH ACETYLENE OR HYDROGEN FLAME

BY S. W. MILLER†

TO the general public, the method of cutting steel by the use of the oxy-acetylene torch is probably better known than the operation of welding. It certainly is more spectacular, on account of its application to the wrecking of burnt steel frame buildings, obsolete bridges, etc., which is work that is generally done in view of a large number of people. As a general rule, the cost of cutting by this process is less than by any other means, and in some cases the saving effected is very great. For instance, in armor plate plants, it is common practice to cut 16-inch armor plate at the rate of nineteen feet per hour, a speed which cannot be attained by any other process. This is done at an expense so low that it is not comparable with the cost when done by ordinary machines. The time element enters largely into such cases, as well as the fact that irregular shapes can be produced as readily as straight lines.

The principle of oxy-acetylene cutting is based on the fact that if a piece of steel or iron is brought to a red heat and a jet of pure oxygen is turned against it, the metal will be oxidized or will burn. It is frequently thought that the process is one of melting the metal. This is not correct, as the metal is simply burnt away where the jet of pure oxygen comes in contact with it. In other words, it is simply an intensified form of oxidization or rusting.

The Cutting Torch

The ordinary cutting torch consists of a heating jet using oxygen and acetylene, oxygen and hydrogen, oxygen and coal gas, or in fact, any other gas which when combined with oxygen will produce heat. By the use of this heating jet, the metal is brought to a sufficiently high temperature and an auxiliary jet of pure oxygen is turned onto the red hot metal, when the action just referred to takes place.

The early form of torch for cutting was generally an ordinary welding torch with an extra tube carrying the auxiliary oxygen at the necessary pressure, which was clamped to the welding torch when it was desired to cut. Of course the cutting jet has to follow the welding jet, and hence such torches were unsatisfactory, because it was necessary to turn them around when the direction of cutting was changed. It was also difficult to bring the cutting jet as close to the welding jet as desirable. Later the auxiliary jet of oxygen was placed between two or more welding jets in one tip, so that no matter what the direction of the cut, the torch could be held in the same position, making it more convenient for the operator and consuming much less time.

The Operation of Cutting

The operation of cutting is one that is very readily learned. The difficulty increases considerably with the thickness of the metal, but for all ordinary thicknesses, a few hours' instruction will enable good and economical work to be done. It is impossible, however, to cut very smoothly by hand, as the torch cannot be held sufficiently steady to do work which requires great accuracy. Cutting machines have therefore been produced which not only cut straight and clean, but also make a very narrow kerf, which, of course, implies a considerable reduction of the oxygen used, as compared with that consumed in hand cutting.

The principal difficulty encountered in cutting is the presence of scale, rust, paint or other foreign matter, which will not burn, or which interferes with the passing away of the slag or oxide formed during the process. It is therefore advisable, and in many cases absolutely necessary, to remove these substances before doing the work. For example, in cutting up old boilers in a district in which the water contains lime or other impurities, it is almost certain that the inside of the boiler sheets will be coated with scale. This scale must either be removed by pounding the outside of the boiler with a sledge at the points where the cuts are to be made, or it must be chipped off from the inside. In the case of bridges with several heavy coats of paint, it is sometimes necessary to remove part of it by burning off with an ordinary gasoline torch, or by some other method. Not only is time saved by doing this, but the consumption of oxygen, which is very much greater in cutting than in welding, is greatly reduced. Without exception, it pays to take the precaution of removing such foreign matter.

In cutting a comparatively thin piece, say ½ inch thick, a beginning can be made at the top and edge of the piece by holding the heating flame at that point, and as soon as the metal becomes red hot, turning on the auxiliary jet of oxygen. The thickness is not sufficient to prevent the slag from being blown out through the bottom of the cut, which is necessary in all cases. It is evident, however, that in the case of a somewhat thicker piece, it would be advisable to begin at the bottom of the edge instead of at the top, so that the slag would be sure to be blown out and fall through easily. It is apparent that the thicker the piece, the higher must be the pressure of the auxiliary jet of oxygen to force the slag out. It will also be clear that unless the slag is kept in a melted condition, it will clog the bottom of the slot and stop the proper action of the torch.

Any lack of continuity in the piece being cut, such as a blow-hole in a steel casting, will make it impossible to cut through the piece. This is the reason why it is more difficult to cut through two or more pieces of sheet steel riveted together than through a single piece of the same thickness. The mill scale on steel sheets is not generally removed when they are riveted together and this breaks the continuity of the metal in the joint.

It has been found possible, however, to cut as many as twelve or fourteen pieces of material, ¼ inch thick, if the scale is cleaned off and the pieces clamped together tightly. This can be done by hand only with difficulty, although it is readily done and a smooth, clean and uniform cut obtained when the work is done on the "oxygraph" or a similar power-driven machine. The possibility of cutting a number of pieces at the same time reduces the expense of such work materially, and makes profitable some operations which, if they had to be performed on single sheets, could not be done economically on account of the high cost of labor and gases.

In view of such difficulties as blow-holes in steel castings, scale on sheets, etc., it is generally unsafe for a welding shop to make a flat or contract price on any cutting job, even after an inspection of the work to be done. A better plan is to cover the labor charge and overhead expenses, profit, etc., by an hourly rate, and make a reasonable charge for the gases used. The gas consumption cannot be determined except by separating the gases used by the heating and auxiliary jets, respectively. A fairly accurate figure for the gases used by the heating jets can be obtained from the manufacturers of the torch, but the oxygen used in the auxiliary jet will vary so much, due to the opening and closing of the valve and the change of pressure necessary for the requirements of the case, that it is impossible to do any more than guess at the amount consumed, by reading the gage on the oxygen tank. Of course in the case of a long job, the total amount of oxygen can be obtained quite accurately from the number of tanks used, but this cannot be used as a basis for other jobs without considerable risk.

Metals that can be Cut

Only wrought iron and steel can be cut by the oxy-acetylene flame. An appreciation of the real action which takes place during the cutting of iron or steel will make clear why cast iron and other metals cannot be cut. If a very thin strip of steel, such as a watch spring, be heated red hot and plunged

* For further information on oxy-acetylene welding, see "Oxy-acetylene Welding Practice," in the March, 1916, number of MACHINERY, and articles there referred to.

† Address: Rochester Welding Works, Rochester, N. Y.

in a jar of pure oxygen, the steel will immediately take fire and burn, and if there is a sufficient amount of oxygen, the burning will continue until the steel is consumed. Again, if a piece of steel be heated red hot and kept at this temperature, a simple jet of oxygen will cut through it, the requirements for cutting being that the metal be brought to a sufficiently high temperature to combine with the oxygen rapidly.

The other essential feature of the process is the removal of the oxide which results from the combining of the oxygen with the metal. In the case of ordinary low-carbon steel, the melting point of the metal is higher than the melting point of the oxide, and as the action of the cutting is largely self-sustaining, that is, the heat from the melted slag materially helps to raise the temperature of the steel in contact with it to the necessary point for the continuation of the process, it appears that the slag will flow away without mixing with the metal. On the other hand, with high-carbon steels, the melting point of which is very nearly that of the oxide, there is a considerable tendency for the metal to melt under the heat of the slag and for the two to mix, preventing the oxygen from reaching the clean metal, as it does when the slag flows away smoothly. However, high-carbon steel can be cut, but if an attempt is made to cut a piece of chilled iron, it will be found that, while the action starts, it will not continue; that is, the metal will not fly out of the cut in sparks, but will drop in little globules of melted metal.

The reason for selecting chilled cast iron for the experiment is that there is no graphite in it, all of the carbon being in the combined state, while in ordinary cast iron, part of the carbon is in the form of graphite, which, of course, interferes with the action to an even greater extent than is the case with chilled iron, on account of the lack of continuity of the cast iron grains between which the graphite is located. Hence, cast iron cannot be cut by the oxy-acetylene torch.

Again, if malleable iron be tested with a cutting torch, it will be found that a white-heart casting, which is really a low-grade steel, will readily cut, because the percentage of carbon is lower than in the case of the chilled iron of which it was made; while if a rather thick black-heart casting be tested, with an outer skin in which the percentage of carbon is low enough to entitle it to be called steel, and a center containing the same percentage of carbon as the chilled iron of which it was made (although its form has been changed to that of temper instead of combined carbon), it will be found impossible to cut. However, the writer has done a large amount of cutting in cases of thin sections of black-heart malleable iron, with satisfactory results. It should be understood, however, that the edges of the cut are not smooth, and that the action in the center of the piece was more that of melting than of cutting. For the results desired, however, these imperfections were immaterial. The sections were not over 3/8 inch thick, and generally not over 1/4 inch.

Different Gases Used

The use of the cutting process has been extended to exceedingly thick sections, particularly in the case of armor plate, as already referred to. In the case of such heavy metal the oxy-acetylene flame is much shorter than the oxy-hydrogen flame. As it is necessary to keep the slag in a melted condition, the longer flame is preferable, so that for all heavy cutting, hydrogen is used rather than acetylene. With a more general introduction of electrolytic plants for the production of oxygen, the use of the oxy-hydrogen flame for cutting may be expected to develop at a rapid rate, as hydrogen, in this case, may be considered as a by-product. It also has the advantages of being free from danger when compressed to any pressure, and of being readily handled in tanks of the same light weight as oxygen tanks. Coal gas or ordinary illuminating gas, being largely composed of hydrogen, can also be used with very satisfactory results for cutting, and in one case, at least, it is used exclusively, being much cheaper than either acetylene or hydrogen. For the best results, however, each of these gases requires a torch with the openings properly proportioned and different from those for the other gases.

Temperature of the Oxygen

One very important factor in the cost of cutting is the temperature of the oxygen in the cutting jet. Anyone who has handled oxygen tanks in cold weather knows that when the valve is open, and oxygen allowed to escape at a fairly rapid rate, the valve body and other parts in the vicinity become coated with snow or ice formed by the condensation of the moisture in the surrounding air. This is caused by the heat absorbed from these parts by the expansion of the gas. It is evident that under such conditions the issuing gas is very cold, and when it is used in cutting, the tendency is to cool the slag and metal and delay the operation of the process. It would appear to be very easy to place a small steam coil around the head of the torch through which the oxygen used for cutting would pass, thus preheating it. In fact, such torches have been constructed, although, as far as the author knows, they are not in use in this country; an increase in cutting speed of from 15 to 25 per cent is claimed for them. In the case of large cutting, the oxygen could be preheated in a special heater in the same way as is often done with compressed air.

Effect of Heat on Steel

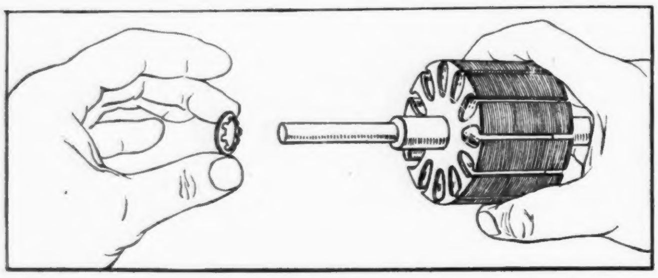
What effect has the heat from cutting on the percentage of carbon in the vicinity of the cut? This point arises, particularly in the case of high-carbon steel used for dies, a large number of these now being cut on automatic machines, particularly where the shape of the die is irregular. It can be stated with perfect confidence that no change occurs as far back as to injure the steel for this purpose, for while there is a slight decarbonization of the steel, the depth to which it penetrates is less than the amount removed in finishing the die. An examination of annealed pieces under the microscope shows this to be the case, the structure being uniform after the annealing treatment, except for a distance of less than 0.020 inch from the cut surface. The change in the structure should preferably be remedied by annealing from above the recalescence point after the cutting is done, because the change in structure is always accompanied by some strain which would possibly cause trouble later by distorting the die when hardening. Of course, no good diemaker would think of hardening a piece of steel without removing the surface for at least 1/32 inch to take off the decarbonized portion. The same condition—and no worse—exists where oxy-acetylene cutting has been employed.

* * *

Tungsten is one of the rare metals that has been found extremely useful in the industrial arts. It is the constituent in high-speed steel that gives it the "red hardness" characteristic and enables it to stand up at cutting speeds far beyond those possible with carbon tool steels. Tungsten has a high specific gravity or density, ranging from 19.3 to 20.2, depending upon the treatment. The melting point is so high that it cannot be melted directly into a mass, and for this reason is obtained from the tungsten bearing ores only as a metallic powder. By indirect means tungsten can be worked into solid masses, ranging from fine wire to chunks weighing two or three pounds. It does not oxidize readily and is practically insoluble in the common acids. Its hardness varies from 4.5 to 8 (razor steel is rated from 5 to 5.5). It is harder than quartz, which has a hardness of 7, and is almost as hard as topaz. Tungsten forms alloys with other metals besides steel. It has many other uses than the manufacture of high-speed steel, being used instead of platinum and platinum-iridium alloys, as contact points in spark coils, voltage regulators, telegraph relays and spark plugs for gas engines. It is also used for phonograph needles, writing pens, drawing dies, knife blades, gas engine valves, etc. Considerable quantities are used for the filaments of tungsten lamps. Tungsten wire may be drawn to smaller sizes than any other known metal. The use of tungsten is recommended for standard weights, since in the wrought state it can be made so hard that it will readily scratch glass and still remain ductile. Being non-oxidizable under ordinary atmospheric conditions, it remains wonderfully constant. The price of tungsten was only $6.50 per unit before the outbreak of the war. A unit is one per cent of a ton in tungsten trioxide. Since the outbreak of the war, the price has risen extraordinarily because of the difficulty of getting it from abroad, the price of pure tungsten now being about $10 a pound or thirty times what it was two years ago.

SNAPSHOTS ON THE ROAD

WEDGE WASHER FOR HOLDING ARMATURE SHEETS ON SHAFT—EFFICIENT LIGHTING SYSTEM—PREVENTING REPAIRS ON SLAG CARS—TIME-SAVING ESTIMATE SHEET



"By squeezing the wedge washer onto the shaft, the teeth would lock into the shaft, holding the punchings"

WE can never tell just what little remark or incident may lead to the passing of an important bit of information. To illustrate—a manufacturer of electrical apparatus had shown MACHINERY'S field service editor through the shop and was about to say goodby, when the editor drew from his pocket a sample of a wedge washer. It was originally made for locking a nut on a screw, and as it was something new it interested the manager at once.

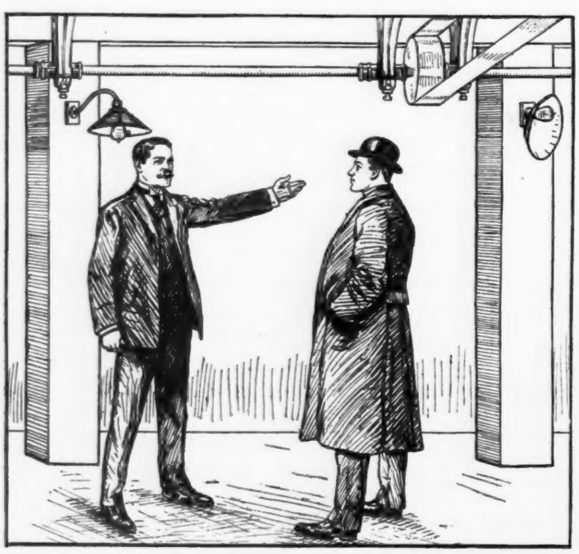
"Do you think it would be possible," said he, "to assemble armature sheets for a small motor on the shaft and hold them in place by a flange collar and this washer? By squeezing the wedge washer onto the smooth shaft, the teeth of the washer would lock into the shaft, forming a collar and holding the assembled punchings."

"Say, I believe that idea would work out fine," said the shop manager, "just give me the name of the man who makes those wedge washers and I'll soon get in touch with him."

And the result—well, if you happen to run into a certain line of electrical apparatus that has the armature punchings locked in place on the shaft with a wedge washer, just remember that you read about it in MACHINERY.

An Efficient Lighting System

"Come down in the new shop," said the manager, "I want to show you how I'm lighting the erecting floor."



"The men have plenty of light over the benches and still there is plenty for the erecting floor"

So down they went, and on the way the manager explained the problem he had. "You see, I couldn't put in overhanging arc lamps because they would be either too high above the floor to be effective or else they would be in the way of the traveling crane. I'm a great believer in tungsten incandescent lights, anyhow, and I wanted to use them this time if I could, but the question was how to throw the light out on the floor and still have it over the erectors' benches. So here's what I did," said he, as he pointed along the central bay, "on one side of every other post I put an incandescent lamp with a wide shade arranged in the usual way. On the alternate posts I put incandescent lamps with the shades inclined at an angle so as to throw the light out into the middle of the floor. Then on the opposite side, I had the lights arranged exactly opposite so that each inclined light works against a straight light, and *vice versa*."

"Well, how does it work out?"

"Work out? Why, the scheme works fine! The men have plenty of light over the benches and still there is plenty for the erecting floor. Not only that, but just see for yourself how the opposing lights kill the shadows."

And the manager was right.

Preventing Repairs on Slag Cars

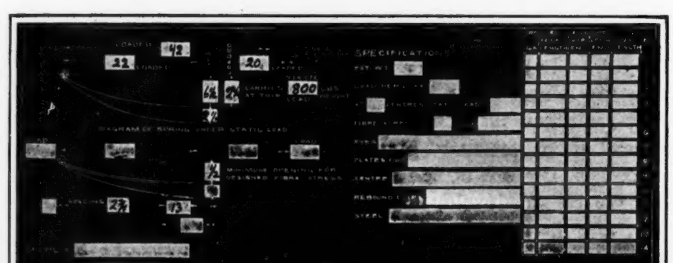
"We used to have to replace the bottoms of those slag cars often because the hot slag wore them out so quickly"

"Say," said the general superintendent as he sat at his desk looking out into the yard between the factory buildings, "there's a case where a little hint saved me a thousand dollars a month, and the saving is going right on continuously."

"How—what do you mean?" said the field service man as he followed the superintendent's glance up along a line of slag cars in front of the foundry.

"It's all so simple it hardly seems worth telling, but up to a few months ago we used to have to replace the bottoms of those slag cars very often because the hot slag wore them out so quickly—in fact, the heat simply burned them out. One day I had a visiting foundryman in here showing him around, and was complaining about the expense of repairs on slag cars.

"'Why, that's easy,' said the visiting foundryman, 'we used to have the same trouble, but we've overcome it almost entirely by keeping a little water in the bottom of each car.'



"When an estimate was to be made, it was simply a matter of filling in the blank spaces with the information"

"Well, say, I was ashamed to think that I hadn't seen that same remedy myself, but you can bet your bottom dollar that I'm keeping water in every slag car I have now, and the result is the chopping off of about 90 per cent of the repair bills on the cars."

This is just one more instance of the value of the right kind of a shop visitor.

A Time-saving Estimate Sheet

Up state on the field service man's last trip he ran into a little kink that ought to be of assistance to any man who has estimating to do.

"You see, it's this way," said the chap who passed the tip along, "I have lots of estimating to do on steel spring contracts. Every time I made out an estimate sheet I had to carry through the same list of questions concerning length of springs, width and gage of plates, loads, weights, etc. So I devised this blueprint form, leaving blank spaces where the figures that varied with every estimate were to go. Then, when an estimate was to be made, it was simply a matter of filling in the blank spaces with the information, and the job was done. Of course, I could have used a printed form, but we hardly had enough estimating to set up an expensive type form, and then, too, the average mechanical man pays more attention to a blueprint than to a printed card. It's a simple little kink, but some fellow in the estimating line may find it of use.

* * *

LAY-OUT AND OPERATION OF A BRIGHT DIP

BY GEORGE B. MORRIS[*]

Where there are a great many brass parts to be finished, especially in shops where repair parts are brought in for refinishing, a bright dip is almost indispensable. A piece that is badly tarnished, and that would ordinarily require a polishing or buffing operation, can be put into even better condition by the use of a bright dip, and the latter method is much quicker. An ideal lay-out for a bright dip is in the corner of the plating room; this is far superior to locating the tanks along a side wall, which will be apparent from the following description.

The brass parts to be bright-dipped are first thoroughly washed in a potash cleaning solution, in the same way that they are before plating. If several small pieces are to be bright dipped it is advisable to wire them together, while in handling large pieces a brass hook answers the purpose very nicely. After cleaning, the piece is first dipped into cold water and then into the acid crock. The acid solution is made of equal parts of commercial nitric and sulphuric acids; and a cupful of common salt is added to the contents of a 20-gallon crock. The piece must not be left too long in the acid—less than a second is often long enough—and one dipping is usually sufficient; but the experienced workman may find it advisable to dip a piece more than once, depending upon the nature of the metal.

[*] Address: Kenmore, N. Y.

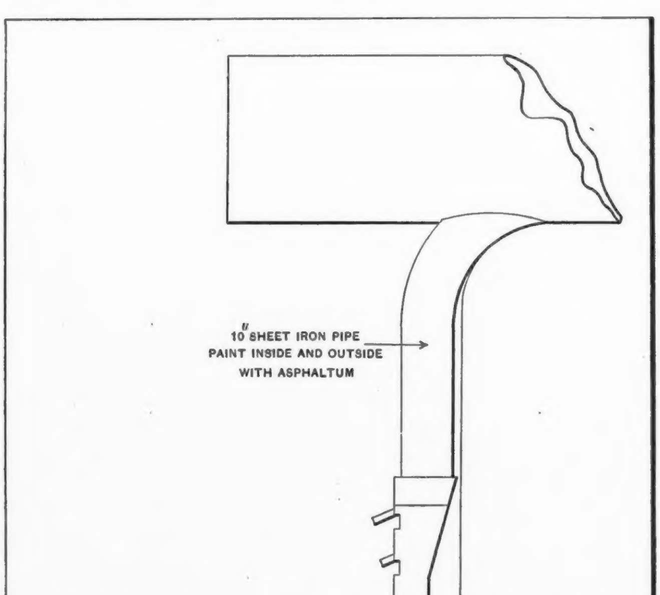


Fig. 1. Lay-out of Bright Dip Plant in Corner of Plating Room

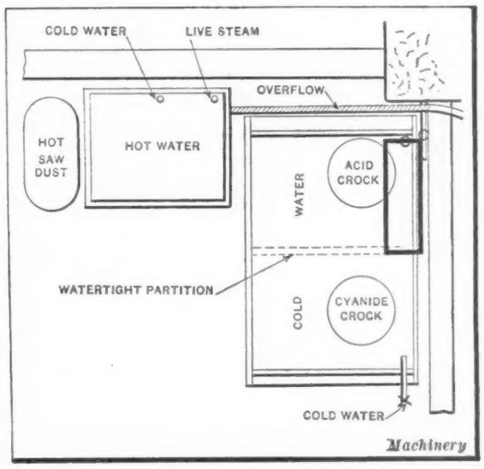


Fig. 2. Arrangement of Exhaust System for Acid Fumes

Upon being taken from the acid, the piece is again dipped in cold water, after which it is dipped in the cyanide crock for an interval of a second or two, the purpose being to remove all signs of tarnish from the surface of the metal. In making up the cyanide solution, 1½ pound of cyanide crystals is dissolved in a 20-gallon crock of water. In some cases it may be found advisable to dip the work in the cyanide solution two or three times, but there is no need of caution in regard to the length of time that the work is left in—as in the case of the acid solution—as no harm will be done if the work is left in for several minutes. After being removed from the cyanide crock, the work is again dipped in cold water, and then into hot water to heat the metal so that it will dry quickly. If the drying takes too long the work is likely to have a streaky appearance. For small work it may be advisable to use a hot sawdust bath, which is simply a box filled with sawdust and having steam coils for heating to the required temperature.

Attention is called to the water-tight partition in the cold-water tank and also to the cold-water faucet in Fig. 2. The partition is a little lower than the sides of the tank, allowing the water on the right-hand side of the partition to flow over into the left-hand compartment; the pure water is contained in the right-hand compartment. As the operator becomes experienced, he will learn when to add more cyanide crystals to the cyanide solution, and he may find it advisable to vary the proportions of nitric and sulphuric acid in the acid solution; if the action of the acid is too slow, more nitric acid should be added. It may also be found advisable to heat the metal in hot water before dipping it in the acid, but this method of treatment is the exception rather than the rule, and is done simply to stimulate the action of the acid.

With a bright-dip outfit, it is absolutely necessary to have an exhaust system for the acid crock, as the acid fumes are both disagreeable and injurious. The accompanying illustrations show the arrangement of the bright dip in the factory where the writer is employed, and they also show clearly the arrangement of the exhaust system for the acid crock. This exhaust system was installed to replace an old style "umbrella" hood which was found inefficient in carrying off nitric acid fumes, owing to the fact that these fumes are slightly heavier than air and do not rise. For a small establishment it is not necessary to have such a large exhaust pipe, but in the present case the exhaust is the one which is opened into the room for ventilating the whole plating department. For a small shop, the exhaust pipe may be carried down from the exhaust system used in connection with buffing wheels. After the parts have been bright-dipped and thoroughly dried, they should be lacquered with an air drying lacquer to prevent tarnishing.

MAKING A PRESSED STEEL BALL RETAINER

BY ERNEST WALTERS*

The pressed steel hub ball retainer illustrated at *B* in Fig 1 is made of 12-gage cold-rolled steel; it is drawn from a developed blank 7 1/16 inches in diameter and is finished in two operations. Shell *A* is blanked and drawn in the compound die shown in Fig. 2, and in setting this die it is important to make a careful adjustment in order that just the required pressure may be developed by the rubber buffer. If this pressure is too great, the diameter of the shell will be increased to such an extent that it will not enter the die shown in Fig. 3, in which the final operation is performed. On the other hand, if the rubber buffer does not exert enough pressure, wrinkles will be formed in the shell, that are likely to develop into cracks.

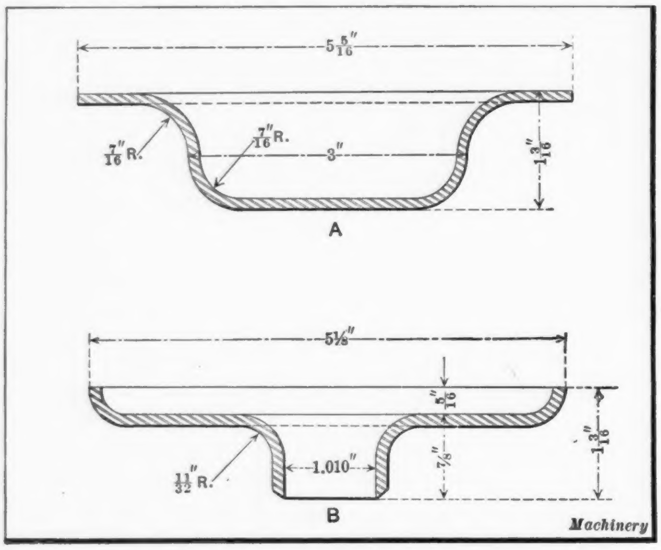


Fig. 1. Shell A after First Operation, and Finished Hub Ball Retainer B

In blanking and drawing the shell to the form shown at *A* in Fig. 1, it has been found convenient to use an inclinable power press which allows the die to discharge the shell instantly so that the press may be operated continuously. When punch *A*, Fig. 2, moves downward, it enters the opening in blanking die *B* and stamps out a blank of the required size. The way in which the blanking die is supported in cast-iron holder *C* will be evident from the illustration. As the downward motion of the punch continues, the blank is carried down into contact with forming punch *D*, which draws it to the shape shown at *A* in Fig. 1.

* Address: 219 W. Buena Vista St., Highland Park, Mich.

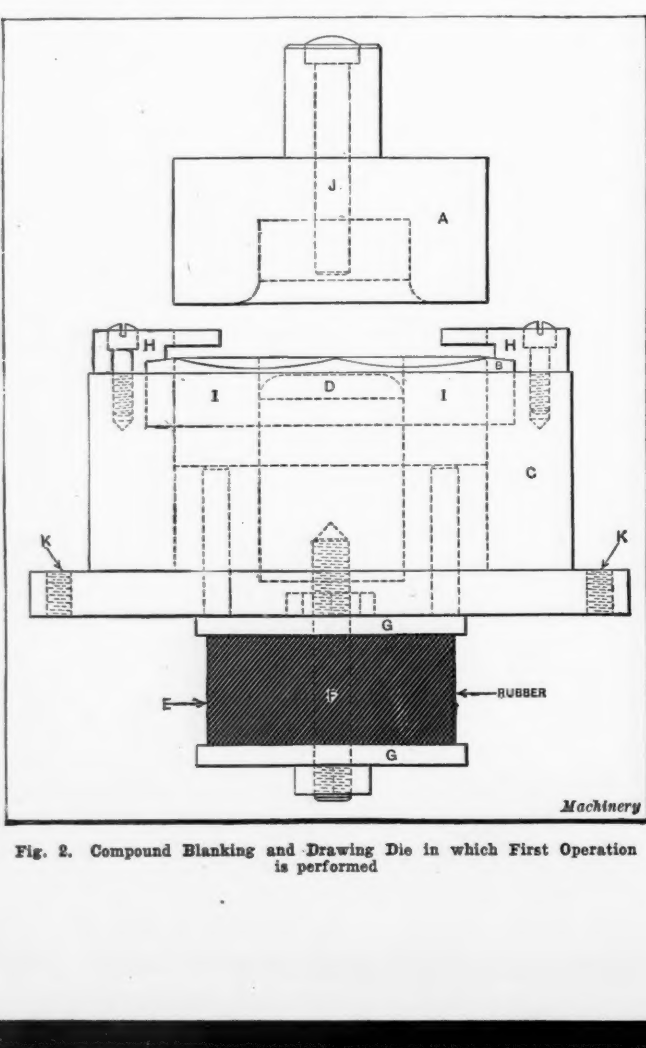


Fig. 2. Compound Blanking and Drawing Die in which First Operation is performed

It will be seen that forming punch *D* fits in a hole bored in die-holder *C*, and that this punch is held down by means of screw *F*. By means of this screw and plates *G*, rubber buffer *E* applies pressure to plate *I* that holds the work against punch *A*, the amount of pressure applied being regulated by adjusting screw *F*. The work is stripped from the punch by means of stripper plate *H*, and should there be a tendency for the work to stick in the punch, pin *J*, which engages a stationary knock-out bar bolted to the body of the press, acts as an ejector. It will, of course, be evident that tapped holes *K* are for the purpose of securing the die to the bolster on the press.

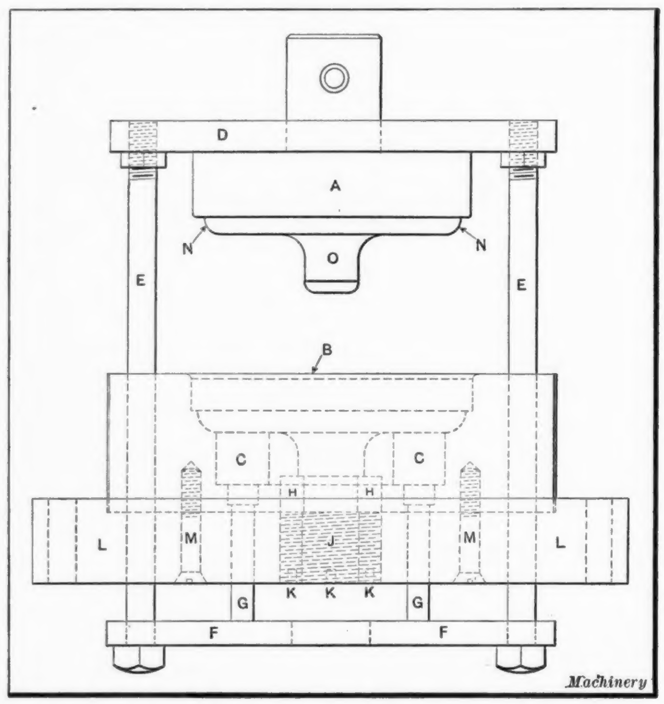


Fig. 3. Drawing and Piercing Die in which Final Operation is performed

After the performance of the first operation, the work is brought to the condition shown at *A* in Fig. 1, and these shells are then turned over and dropped into the forming and punching die, Fig. 3, in which they are drawn to the finished shape *B*, Fig. 1. In Fig. 3, the punch is shown at *A* and the die at *B*. Die *B* is bored out to form a seat for ring *C* which acts as a knock-out to eject the stamping from the die. It will be seen that the punch carries plate *D* which supports knock-out rods *E*; these rods carry plate *F* at their lower ends, and by making a suitable adjustment, plate *F* comes into contact with pins *G* on the up stroke of the ram, thus lifting ring *C* and ejecting the finished stamping from the die.

At the bottom of forming die *B* there is a small hardened steel ring *H* which is bored to fit the pilot on punch *A*. This is the piercing die which provides for punching the hole in the bottom of the stamping. Die *H* is held in place by threaded bushing *J* which is tightened with a spanner wrench fitting into holes *K*. It will be evident that *L* is the die-plate and that the die is secured in place by means of screws *M*.

In performing the final operation in this punch and die, which brings the work to the form shown at *B* in Fig. 1, shell *A* is put in the die upside down, and when the punch descends it turns the shell inside out and punches out the bottom. When the shell starts turning, the flange turns upward and comes into contact with the shoulder *N* on the punch, which forces the stock into the die. Pilot *O* on the punch forms the hub of the retainer and punches out the bottom without stretching the stock. The pilot is 3/16 inch longer than the hub of the retainer, which gives the punch the necessary over-travel to upset the end of the hub and prevent leaving a ragged edge.

HIGH-POWER SPRING MOTOR

BY SVEND HELWEG*

With the assistance of a friend, I have been experimenting for some time with what I believe to be a new form of spring motor which varies from the ordinary type in having batteries of springs wound from heavy tempered round wire in place of the common flat clockwork spring. The motor is more powerful than the ordinary type and will run for a much longer time; the operating life of a motor constructed in this way is also longer, as there is no danger of overwinding the heavy springs employed. In the motor shown in the illustrations only four batteries of springs are used, each battery consisting of three springs; but the number of springs in each battery—as well as the number of batteries—could be increased or decreased according to the amount of power which the motor is required to generate.

This type of spring motor consists of four main sections; first, the cranking mechanism; second, the batteries of springs; third, the transmitting mechanism; and fourth, the speed control. The illustrations plainly show the general features of the design, so that it will only be necessary to give a brief description of the motor. The cranking section and the transmitting section may be made to suit various conditions under which the motor is to be used, depending largely upon the kind of power applied for cranking and the amount of power to be developed by the spring motor. Any suitable form of governor mechanism can be employed for controlling the speed. All four sections of the motor may be mounted in a steel or cast-iron frame which may be placed in any convenient position. A spring motor may be used in a fixed position or it can be housed in a movable cabinet to enable the motor to be carried about from place to place.

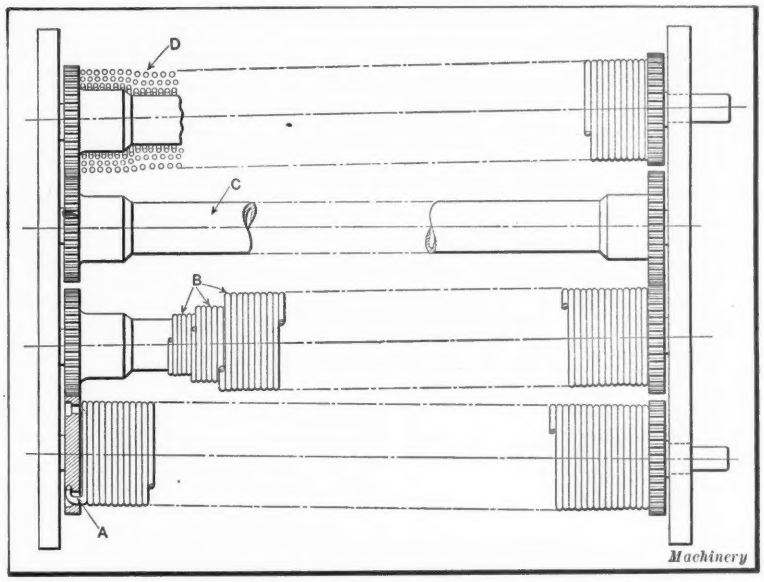


Fig. 1. Construction of Spring Batteries and Arrangement of Geared Drive

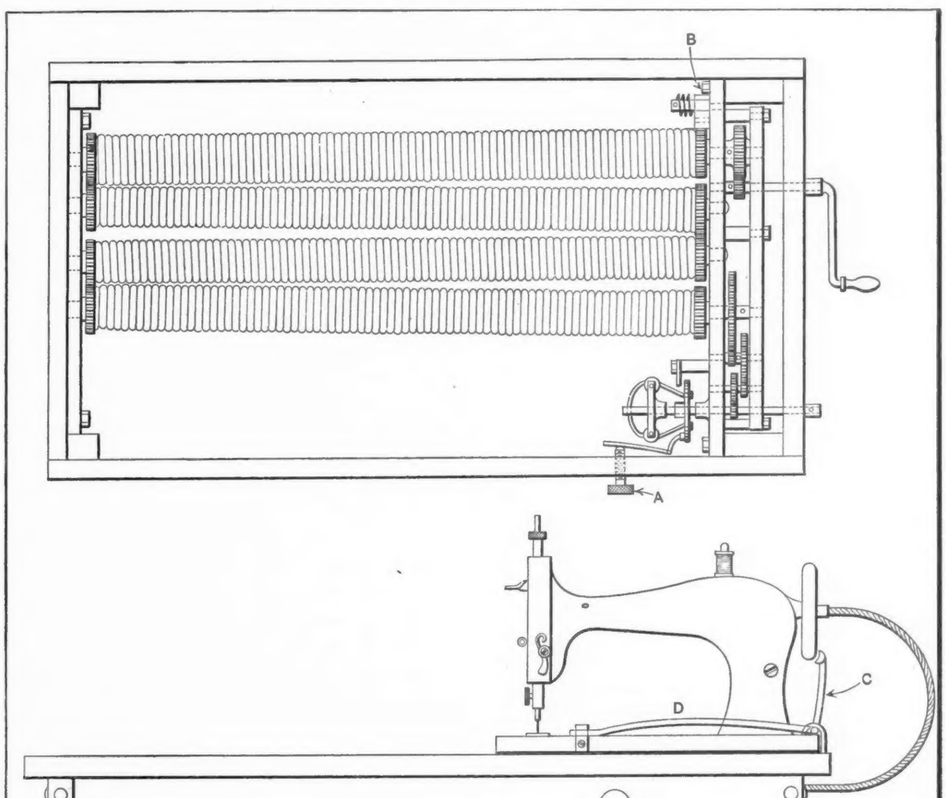


Fig. 2. Application of Spring Motor for driving Sewing Machine

Fig. 1 shows the construction of the spring batteries, the motor being shown with the springs unwound. At *A* is shown the way in which the springs are connected to the gear wheels; for this purpose the end of each spring is bent to form a hook which fits into a hole provided for that purpose in the gear wheel. Three springs wound from wire of different diameters are mounted one outside the other on the same roller, as shown at *B*. The springs have been removed from the third battery in order to show the reel *C* made of hollow steel tubing on which the springs are wound; the design of this spool is worked out in such a way that it prevents the springs from being overwound and also holds them in place. A partial cross-sectional view through the springs is shown at *D* and gives a little clearer idea than is shown at *B* of the arrangement of concentric springs wound from wire of different sizes. The rollers are mounted on ball bearings, and it will be seen that the drive is transmitted through gearing, the gears on adjacent shafts coming into mesh alternately at opposite ends of the shafts. When cranking the motor, the coils on each individual spring are gradually contracted until they have

* Address: 1121 E. 15th St., Brooklyn, N. Y.

reached the limit fixed by the outside diameter of the reel.

Fig. 2 shows a sewing machine driven by a spring motor. In this instance the motor is mounted inside a table and connected with the sewing machine by means of a flexible shaft. Screw *A* controls the expansion of the governor for regulating the speed at which the machine is driven. A ratchet wheel and pawl located at *B* make it impossible for the motor to run back, and a buffer brake is provided at *C*, which was especially designed to meet the requirements of this application of the motor. By pressing down spring *D* the operator can stop the sewing machine at any time, bringing brake *C* into operation, and when the brake is released the motor starts itself. With this arrangement of the spring motor, it is an easy matter to disconnect the sewing machine and couple the motor to any other apparatus, such as a rotary fan for instance; in the latter case, the use of the spring motor does away with the necessity of paying for electric current to operate the fan with an electric motor. This spring motor, provided with four batteries having three springs each, will drive a sewing machine for about five hours. I have used this motor in my home for over a year and have not experienced the least trouble with the mechanism; if I wind the motor in the morning my wife can use her sewing machine all day long and she says that it makes sewing a pleasure.

Last summer we tried the experiment of connecting the spring motor with a graphophone and the results were entirely satisfactory; we could play the instrument for three hours without the necessity of rewinding the motor. Encouraged by the results of this experiment, we built a smaller motor, *i. e.*, with shorter springs, and mounted it inside a standard graphophone cabinet with the springs in a vertical position. A flexible shaft was used to connect the gearing to the mechanism of the graphophone. This little spring motor kept the graphophone running for an hour and a half as compared with fifteen minutes, which is the limit for an ordinary clock-spring motor. The spring motor could be mounted in a separate cabinet, making it easy to move from place to place, and the same motor could then be used for driving both the sewing machine and the graphophone, and for numerous other purposes.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Purchaser Only Entitled to Damages

(Federal) A contract for the sale of an engine contained certain guaranties, and provided for an endurance test by means of which the engine should be shown to possess the qualities specified, and that, if the engine did not fulfill the test or satisfy the guaranties, the purchaser should not be required to pay therefor, and the engine should be forthwith removed. The test left the question whether the engine fulfilled the guaranties in controversy, and the purchaser, though continuing to use the engine, refused to accept it or pay for it.

An action was brought for the price of the engine by the manufacturer and it was held that a recovery for the purchase price should be allowed. As a matter of fact, the engine failed to meet the test to which it was subjected, but the court held that the continual refusal of the purchaser either to accept or return the engine made it liable for the purchase price. Keeping and using the engine caused title to pass to it, and from that time the guaranties ceased to be conditions precedent and became collateral agreements, for the breach of which the purchaser was confined to a recoupment of damages, as its conduct in continuing to use the engine was conclusive evidence that the engine was a substantial performance of the contract. *(Crescent Milling Co. v. Strait Mfg. Co., 227 Fed. 808.)*

Entitled to File Creditor's Claim

(Federal) Where machinery was leased under a condition that if the lessee became bankrupt, the leases should at the option of the lessor cease, and that upon any breach of the lessee of any of the conditions therein the lessor should have the right by notice in writing to terminate the leases—that upon the termination of the leases the lessee should deliver the machinery to the lessor in good order, reasonable wear and tear excepted, and should thereupon pay certain amounts as reimbursement for deterioration, etc., the bankruptcy of the lessee terminated the lease, and the cost of necessary repairs, return freight charges, etc., became a fixed liability absolutely owing at the time of bankruptcy. The lessor was privileged to file such claim as a general creditor of the bankrupt. *(In re Desnoyes Co., 227 Fed. 401.)*

Machinery May be Real Estate

(Massachusetts) A mortgage described the property as a certain parcel of land, with buildings thereon and all privileges and appurtenances thereto belonging and included with the real estate, and as a part thereof enumerated machinery attached to the premises. At the time of the execution of the mortgage there was other machinery in the building, not specially designed for use in the building, nor peculiar in its pattern. This other machinery was easily removable without injury to it or to the building, and was equally adapted for use in any other similar building. Held, that the intention of the parties is the controlling fact in determining whether a chattel affixed to realty becomes real estate or continues personalty. The question must be determined on consideration of all the circumstances, including the adaptation of the chattels to the end sought to be accomplished, and the means, form, and degree of annexation. A chattel so affixed to real estate that its identity is lost, or so annexed that it cannot be removed without material injury to it or the real estate, is "real estate." *(Stone v. Livingston, 110 N. E. 298.)*

Assignor of Patent Estopped

(Federal) The assignor of a machine patent for value, with covenants of warranty, is estopped, when sued for infringement thereof by the assignee, to deny that the claims cover every structure within the fair meaning of the language of the claims. The words "substantially as described" do not limit the claim to the construction shown in the patent. *(United Printing Machine Co. v. Cross Paper Feeder Co., 227 Fed. 600.)*

Sale and Installation Contract

(Texas) Where a contract for the sale and installation of machinery for irrigation declared that the agreement was subject to delays due to fires, strikes, or other causes, the purchaser could recover damages suffered through delay in installing the machinery after it had arrived, as it is presumed that the contract referred only to delays beyond the control of the manufacturer of the machinery. *(Southern Gas & Gasoline Engine Co. v. Richolson, 181 S. W. 528.)*

Failure to Guard Machinery

(New York) The New York labor law requires all machinery of every description to be properly guarded. Plaintiff operated a machine, the plunger of which was set in motion by pressure on a treadle, and his hand was injured by pressure accidentally applied to the treadle by another workman who was not operating the machine, and who voluntarily and outside the line of his duty, and in disobedience of plaintiff's request, attempted to pick up material which had fallen on the floor near the machine. Held, that, assuming that it was practicable to guard the treadle, and that the employer would have been liable if the machine had been put in motion by some accidental movement reasonably to be apprehended, plaintiff was not entitled to recover, as the risk or accident was one not reasonably to be anticipated, since the operator of the machine, in stooping to pick up fallen material, could not leave his hand where it would be injured by pressure on the treadle. *(Basel v. Ansonia Clock Co., 110 N. E. 767.)*

* * *

Bill H. R. 6458 has been introduced providing for the registration of designs. The move to secure legislation for the protection of designs is promoted by the National Design Legislation Relief, Loan & Trust Bldg., Washington, D. C. It provides that the author of any new and original design as applied to any manufactured product may have it copyrighted and obtain certificate of such registration. The bill if enacted will provide for the adequate registration of designs and should check the stealing of designs, which is now so common.

SCREWS USED IN JIG DESIGN*

STANDARDIZED SPECIAL SCREWS USED IN GENERAL ELECTRIC CO.'S TOOL EQUIPMENT

BY R. F. POHLE†

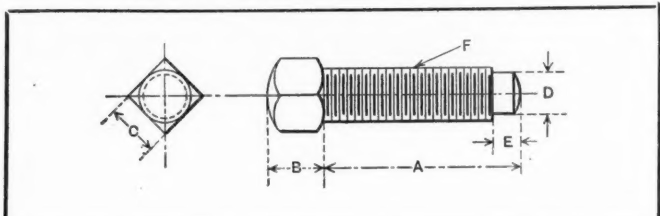
HEADLESS set-screws are used in jig design for binding spring-pins, stop-pins and locating plugs after they have been adjusted to the work. Headless set-screws are made in several styles, but only those having a round or flat point are used in tool design. The flat points are generally used when in contact with finished surfaces. They are occasionally casehardened to prevent the end in contact with the work from becoming upset. Round points are often used as adjustable stops for rough work.

The square-head set-screw is essentially a binding screw; it often replaces headless set-screws when it is necessary to obtain a greater clamping force than can be exerted with a screwdriver. It is also used for clamping work against stops, when great rigidity of the work is required, or when the screw must take the thrust of cutting tools. As these screws require

* The tables of standards given in this article embody the practice of the General Electric Co., at Lynn, Mass. These standards have been developed for the company by R. F. Pohle, who is in charge of the tool designing department.

† Address: General Electric Co., Lynn, Mass.

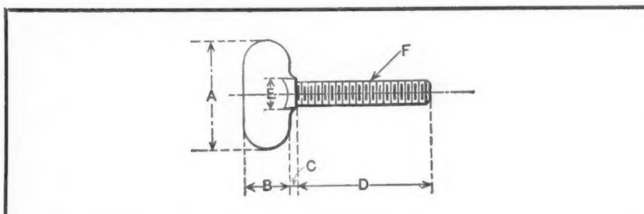
TABLE I. SQUARE-HEAD SET-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
7/8 to 1 7/8	1/4	1/4	3/16	1/8	No. 14—24
1 to 2 1/2	5/16	5/16	15/64	1/8	5/16—18
1 to 2 1/2	3/8	3/8	9/32	1/8	3/8—16
1 3/8 to 2 7/8	7/16	7/16	11/32	1/8	7/16—14
1 3/4 to 3 1/4	1/2	1/2	25/64	1/8	1/2—13
2 1/8 to 4 1/8	5/8	5/8	1/2	3/16	5/8—11
2 1/2 to 4 1/2	3/4	3/4	5/8	1/4	3/4—10

Machinery

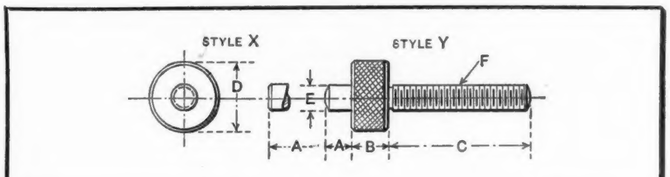
TABLE II. THUMB-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
1/2	13/32	5/64	1/4 to 1/2	3/16	No. 8—32
21/32	1/2	3/64	1/4 to 1	5/16	No. 10—32
21/32	5/8	1/16	1/2 to 1 1/2	3/8	No. 14—24
1 1/8	23/32	1/16	1/2 to 1 1/2	7/16	5/16—18
1 1/4	13/16	7/64	1/2 to 2	1/2	3/8—16
1 9/16	1	9/64	1/2 to 2	5/8	1/2—13
2	1 5/16	3/16	3/4 to 2 1/4	7/8	5/8—11

Machinery

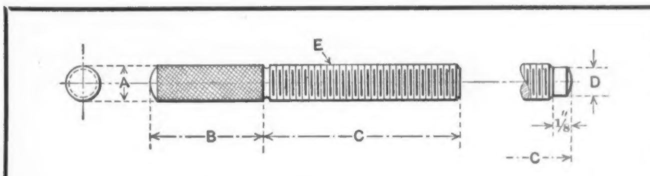
TABLE III. KNURLED JACK-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
3/16	3/16	5/8 to 1 5/8	3/8	3/16	No. 10—32
3/16	5/16	3/4 to 1 3/4	9/16	1/4	No. 14—24
1/4	3/8	7/8 to 2 3/8	11/16	5/16	5/16—18
1/4	3/8	1 to 2 1/2	13/16	3/8	3/8—16
1/4	7/16	1 3/8 to 2 7/8	7/8	7/16	7/16—14
1/4	1/2	1 3/4 to 3 1/4	1	1/2	1/2—13

Machinery

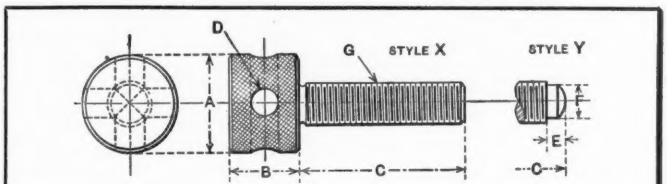
TABLE IV. SCREW PINS



A	B	C	D	E Diameter and Number of Threads per Inch
3/16	5/8	3/4 to 1 3/4	9/64	No. 10—32
1/4	3/4	7/8 to 1 7/8	3/16	No. 14—24
5/16	1	7/8 to 2 3/8	15/64	5/16—18
3/8	1	1 to 2 1/2	9/32	3/8—16
7/16	1 1/4	1 3/8 to 2 7/8	11/32	7/16—14
1/2	1 1/4	1 3/4 to 3 1/4	25/64	1/2—13

Machinery

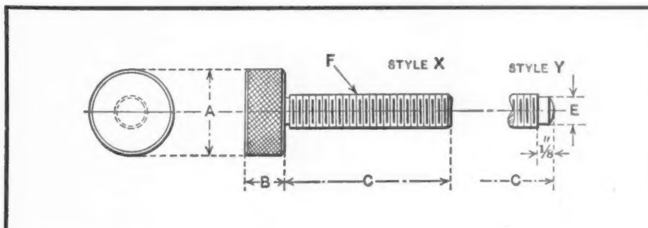
TABLE V. KNURLED CAPSTAN SCREWS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
1/2	5/16	5/8 to 1 5/8	3/32	1/8	9/64	No. 10—32
11/16	3/16	7/8 to 1 7/8	1/8	1/8	3/16	No. 14—24
13/16	7/16	1 to 2 1/2	5/32	1/8	15/64	5/16—18
7/8	9/16	1 to 2 1/2	3/16	1/8	9/32	3/8—16
1	5/8	1 3/8 to 2 7/8	7/32	1/8	11/32	7/16—14
1 3/16	3/4	1 3/8 to 3 1/4	1/4	1/8	25/64	1/2—13
1 5/16	13/16	1 7/8 to 3 3/8	9/32	3/16	1/2	5/8—11
1 1/2	7/8	2 1/4 to 3 3/4	5/16	1/4	5/8	3/4—10

Machinery

TABLE VI. KNURLED THUMB-SCREWS



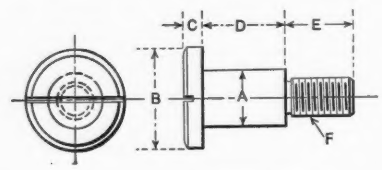
A	B	C	E	F Diameter and Number of Threads per Inch
1/2	1/4	5/8 to 1 5/8	9/64	No. 10—32
11/16	5/16	7/8 to 1 7/8	3/16	No. 14—24
13/16	3/8	1 to 2 1/2	15/64	5/16—18
7/8	3/8	1 to 2 1/2	9/32	3/8—16
1	7/16	1 3/8 to 2 7/8	11/32	7/16—14
1 3/16	1/2	1 3/4 to 3 1/4	25/64	1/2—13

Machinery

a wrench, they do not lend themselves to rapid clamping action. Proportions of square-head set-screws are given in Table I. A pin may be driven through the head on the larger sizes to act as a handle for turning the screws. On the smaller sizes this is not advisable, as the pin must necessarily be so small in diameter that it cuts into the fingers in tightening the screws. It is then better to use the style shown in Table II.

Cap-screws are used for fastening parts to the body of the tool. When the part which they fasten must have an accurate location with reference to other parts of the same tool, they are generally used in conjunction with dowel pins. The clearance holes for these screws are usually made 1/64 inch larger than the head of the screw. Shoulder screws, as shown in Table VII, are used for fastening clamping blocks, latches, or any parts that must move through a limited distance while still remaining permanently fastened to the tool.

TABLE VII. SHOULDER SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
0.249	½	⅛	½ to ¾	7/16	No. 10—32
0.249	½	⅛	3/16 to 7/16	5/16	No. 10—32
0.3115	⅝	5/32	3/16 to ½	⅜	No. 14—24
0.3115	⅝	5/32	9/16 to ⅞	½	No. 14—24
0.374	¾	5/32	¼ to 7/16	⅜	No. 14—24
0.374	¾	5/32	½ to 11/16	½	No. 14—24
0.374	¾	5/32	¾ to 1	⅝	No. 14—24
0.4365	13/16	5/32	⅜ to 9/16	½	5/16—18
0.4365	13/16	5/32	⅝ to 13/16	⅝	5/16—18
0.4365	13/16	5/32	⅞ to 1⅛	¾	5/16—18
0.499	⅞	3/16	⅜ to 9/16	½	⅜—16
0.499	⅞	3/16	⅝ to ⅞	⅝	⅜—16
0.499	⅞	3/16	15/16 to 1¼	¾	⅜—16
0.5615	1	3/16	½ to ¾	⅝	7/16—14
0.5615	1	3/16	⅞ to 1⅛	¾	7/16—14
0.5615	1	3/16	1¼ to 1½	⅞	7/16—14
0.6235	1⅛	¼	½ to ⅝	⅝	½—13
0.6235	1⅛	¼	¾ to 1	¾	½—13
0.6235	1⅛	¼	1⅛ to 1⅝	⅞	½—13
0.686	1¼	¼	⅝ to 1	¾	½—13
0.686	1¼	¼	1⅛ to 1¾	1	½—13
0.7485	1⅜	5/16	¾ to 1⅛	⅞	⅝—11
0.7485	1⅜	5/16	1¼ to 2	1⅛	⅝—11

Machinery

Knurled Thumb-screws

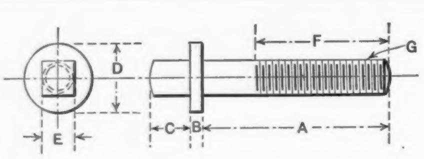
There are four types of knurled-head screws in general use in jig design. These are illustrated and tabulated in Tables III to VI. The knurled screw is adapted to light clamping, and is also used where the work is frail, so that there is danger of bending it, and where it is not necessary to take the thrust of the cutting tool. Where it is necessary to take the thrust of the cutting tool and yet provide for rapid manipulation of the screw, the knurled capstan screw or the fluted capstan screw is used. The knurled capstan screw is screwed up with the fingers, while the fluted capstan screw is screwed up by a pin engaging in the flutes; both are tightened with the aid of a pin.

The knurled jack-screw is designed for supporting work against the action of cutting tools where the nature of the work requires such support at more than three points. If the thrust of the cutting tool is very great, the jack-screw should be locked with a brass plug and set-screw after being adjusted to the work. The points of knurled screws may be either flat or rounded, according to whether they are used on finished or rough surfaces.

Miscellaneous Screws

Collar-head screws are essentially clamp-screws, and are

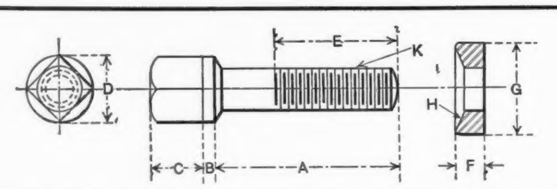
TABLE VIII. COLLAR-HEAD SCREWS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
⅝	1/16	3/16	5/16	3/16	½	No. 10—32
⅞	1/16	3/16	5/16	3/16	⅝	No. 10—32
1⅛	1/16	3/16	5/16	3/16	⅞	No. 10—32
1⅜	1/16	3/16	5/16	3/16	1	No. 10—32
1⅝	1/16	3/16	5/16	3/16	1¼	No. 10—32
⅞	3/32	¼	7/16	¼	⅝	No. 14—24
1⅛	3/32	¼	7/16	¼	⅞	No. 14—24
1⅜	3/32	¼	7/16	¼	1	No. 14—24
1⅝	3/32	¼	7/16	¼	1¼	No. 14—24
1⅞	3/32	¼	7/16	¼	1 7/16	No. 14—24
⅞	⅛	5/16	9/16	5/16	⅝	5/16—18
1¼	⅛	5/16	9/16	5/16	1	5/16—18
1⅝	⅛	5/16	9/16	5/16	1¼	5/16—18
2	⅛	5/16	9/16	5/16	1½	5/16—18
2⅜	⅛	5/16	9/16	5/16	1¾	5/16—18
1	⅛	⅜	11/16	⅜	¾	⅜—16
1⅜	⅛	⅜	11/16	⅜	1	⅜—16
1¾	⅛	⅜	11/16	⅜	1 5/16	⅜—16
2⅛	⅛	⅜	11/16	⅜	1⅝	⅜—16
2½	⅛	⅜	11/16	⅜	1⅞	⅜—16
1⅜	3/16	7/16	¾	7/16	1	7/16—14
1¾	3/16	7/16	¾	7/16	1 5/16	7/16—14
2⅛	3/16	7/16	¾	7/16	1⅝	7/16—14
2½	3/16	7/16	¾	7/16	1⅞	7/16—14
2⅞	3/16	7/16	¾	7/16	2⅛	7/16—14
1¾	3/16	½	⅞	½	1 5/16	½—13
2⅛	3/16	½	⅞	½	1⅝	½—13
2½	3/16	½	⅞	½	1⅞	½—13
2⅞	3/16	½	⅞	½	2⅛	½—13
3¼	3/16	½	⅞	½	2⅜	½—13

Machinery

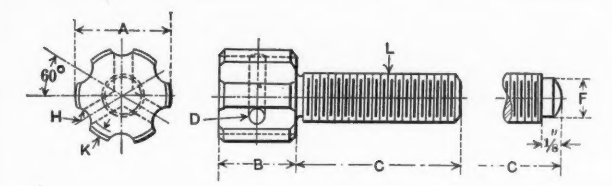
TABLE IX. ROCKING COLLAR SCREWS



A	B	C	D	E	F	G	H	K Diameter and Number of Threads per Inch
⅝	3/32	3/16	11/32	½	⅛	7/16	¼	No. 10—32
⅞	3/32	3/16	11/32	⅝	⅛	7/16	¼	No. 10—32
1⅛	3/32	3/16	11/32	⅞	⅛	7/16	¼	No. 10—32
1⅜	3/32	3/16	11/32	1	⅛	7/16	¼	No. 10—32
1⅝	3/32	3/16	11/32	1¼	⅛	7/16	¼	No. 10—32
⅞	3/32	¼	7/16	⅝	3/16	⅝	½	No. 14—24
1⅛	3/32	¼	7/16	⅞	3/16	⅝	½	No. 14—24
1⅜	3/32	¼	7/16	1	3/16	⅝	½	No. 14—24
1⅝	3/32	¼	7/16	1¼	3/16	⅝	½	No. 14—24
1⅞	3/32	¼	7/16	1 7/16	3/16	⅝	½	No. 14—24
⅞	⅛	5/16	½	⅝	3/16	11/16	½	5/16—18
1¼	⅛	5/16	½	1	3/16	11/16	½	5/16—18
1⅝	⅛	5/16	½	1¼	3/16	11/16	½	5/16—18
2	⅛	5/16	½	1½	3/16	11/16	½	5/16—18
2⅜	⅛	5/16	½	1¾	3/16	11/16	½	5/16—18
1	⅛	⅜	⅝	¾	3/16	13/16	½	⅜—16
1⅜	⅛	⅜	⅝	1	3/16	13/16	½	⅜—16
1¾	⅛	⅜	⅝	1 5/16	3/16	13/16	½	⅜—16
2⅛	⅛	⅜	⅝	1⅝	3/16	13/16	½	⅜—16
2½	⅛	⅜	⅝	1⅞	3/16	13/16	½	⅜—16
1⅜	⅛	7/16	11/16	1	¼	15/16	⅝	7/16—14
1¾	⅛	7/16	11/16	1 5/16	¼	15/16	⅝	7/16—14
2⅛	⅛	7/16	11/16	1⅝	¼	15/16	⅝	7/16—14
2½	⅛	7/16	11/16	1⅞	¼	15/16	⅝	7/16—14
2⅞	⅛	7/16	11/16	2⅛	¼	15/16	⅝	7/16—14
1¾	⅛	½	13/16	1 5/16	¼	1 1/16	⅝	½—13
2⅛	⅛	½	13/16	1⅝	¼	1 1/16	⅝	½—13
2½	⅛	½	13/16	1⅞	¼	1 1/16	⅝	½—13
2⅞	⅛	½	13/16	2⅛	¼	1 1/16	⅝	½—13
3¼	⅛	½	13/16	2⅜	¼	1 1/16	⅝	½—13

Machinery

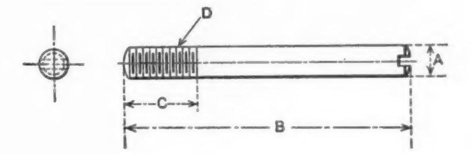
TABLE X. FLUTED CAPSTAN SCREWS



A	B	C	D	F	H	K	L Diameter and Number of Threads per Inch
1/2	13/16	1 to 1 3/4	3/32	9/64	3/32	1/16	No. 10—32
11/16	15/16	1 1/4 to 2 1/4	1/8	3/16	1/8	3/32	No. 14—24
13/16	1 1/8	1 1/2 to 3	5/32	15/64	1/8	1/8	5/16—18
15/16	1 1/4	1 3/4 to 3 1/4	3/16	9/32	1/8	1/8	3/8—16
1	1 3/8	2 to 3 1/2	7/32	11/32	3/16	1/8	7/16—14
1 3/16	1 1/2	2 1/4 to 3 3/4	1/4	25/64	3/16	1/8	1/2—13
1 5/16	1 5/8	2 1/2 to 4 1/2	9/32	1/2	1/4	3/16	5/8—11
1 1/2	1 3/4	3 to 5	5/16	5/8	1/4	3/16	3/4—10

Machinery

TABLE XI. DOWEL SCREWS



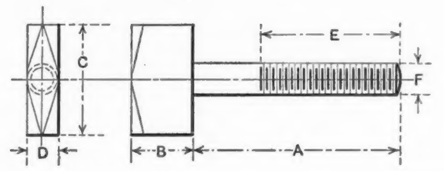
A	B	C	D Diameter and Number of Threads per Inch
0.141	7/16 to 3/4	7/32	No. 6—32
0.166	1/2 to 1	1/4	No. 8—32
0.190	5/8 to 1 3/16	9/32	No. 10—32
0.246	3/4 to 2	3/8	No. 14—24
0.3125	7/8 to 2 1/4	15/32	5/16—18
0.375	1 to 2 5/8	9/16	3/8—16
0.500	1 1/4 to 3	3/4	1/2—13
0.625	1 1/2 to 4 1/2	13/16	5/8—11
0.750	2 to 6	1 1/8	3/4—10

Machinery

used in conjunction with clamps, straps and latches. Rocking collar screws, Table IX, are used with clamps for rough work, since they adapt themselves to any irregularities of the work and give a full bearing on the clamps in any position the work may assume.

Quarter-turn thumb-screws may be rapidly manipulated and are especially of use in box jigs. The only objection to this type of screw is the wear that takes place on the boss on which it acts. In time, the boss wears away sufficiently so that the head of the screw comes in line with the clearance slot in the cover, and then it becomes necessary to finish the boss to a new fit. The great convenience of this type of screw, however, more than makes up for the time required for readjustment, and hence it is extensively used. Half-turn thumb-screws are also used in box jigs when the quarter-turn thumb-screw cannot be used on account of the work or bushing protruding through the end of the jig. These screws are used in pairs, one on each side of the jig cover.

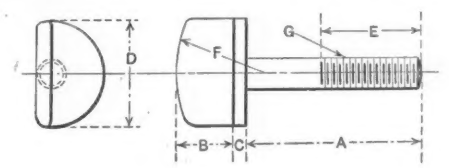
TABLE XII. QUARTER-TURN THUMB-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
7/16	1/2	11/16	3/16	5/16	No. 10—32
5/8	1/2	11/16	3/16	1/2	No. 10—32
7/8	1/2	11/16	3/16	5/8	No. 10—32
1 1/8	1/2	11/16	3/16	7/8	No. 10—32
1 3/8	1/2	11/16	3/16	1	No. 10—32
1 5/8	1/2	11/16	3/16	1 1/4	No. 10—32
5/8	9/16	13/16	1/4	1/2	No. 14—24
7/8	9/16	13/16	1/4	5/8	No. 14—24
1 1/8	9/16	13/16	1/4	7/8	No. 14—24
1 3/8	9/16	13/16	1/4	1	No. 14—24
1 5/8	9/16	13/16	1/4	1 1/4	No. 14—24
1 7/8	9/16	13/16	1/4	1 3/8	No. 14—24
5/8	5/8	1	5/16	1/2	5/16—18
7/8	5/8	1	5/16	5/8	5/16—18
1 1/4	5/8	1	5/16	1	5/16—18
1 5/8	5/8	1	5/16	1 1/4	5/16—18
2	5/8	1	5/16	1 1/2	5/16—18
2 3/8	5/8	1	5/16	1 3/4	5/16—18
3/4	11/16	1 3/16	3/8	9/16	3/8—16
1	11/16	1 3/16	3/8	3/4	3/8—16
1 3/8	11/16	1 3/16	3/8	1	3/8—16
1 3/4	11/16	1 3/16	3/8	1 5/16	3/8—16
2 1/8	11/16	1 3/16	3/8	1 5/8	3/8—16
2 1/2	11/16	1 3/16	3/8	1 7/8	3/8—16
1	3/4	1 5/16	7/16	3/4	7/16—14
1 3/8	3/4	1 5/16	7/16	1	7/16—14
1 3/4	3/4	1 5/16	7/16	1 5/16	7/16—14
2 1/8	3/4	1 5/16	7/16	1 5/8	7/16—14
2 1/2	3/4	1 5/16	7/16	1 1/4	7/16—14
2 7/8	3/4	1 5/16	7/16	1 7/16	7/16—14
1 3/8	3/4	1 5/16	1/2	1	1/2—13
1 3/4	3/4	1 5/16	1/2	1 5/16	1/2—13
2 1/8	3/4	1 5/16	1/2	1 5/8	1/2—13
2 1/2	3/4	1 5/16	1/2	1 1/4	1/2—13
2 7/8	3/4	1 5/16	1/2	1 7/16	1/2—13
3 1/4	3/4	1 5/16	1/2	1 5/8	1/2—13

Machinery

TABLE XIII. HALF-TURN THUMB-SCREWS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
7/16	1/2	3/16	11/16	5/16	3/4	No. 10—32
5/8	1/2	3/16	11/16	1/2	3/4	No. 10—32
7/8	1/2	3/16	11/16	5/8	3/4	No. 10—32
1 1/8	1/2	3/16	11/16	7/8	3/4	No. 10—32
1 3/8	1/2	3/16	11/16	1	3/4	No. 10—32
1 5/8	1/2	3/16	11/16	1 1/4	3/4	No. 10—32
5/8	9/16	3/16	13/16	1/2	7/8	No. 14—24
7/8	9/16	3/16	13/16	5/8	7/8	No. 14—24
1 1/8	9/16	3/16	13/16	7/8	7/8	No. 14—24
1 3/8	9/16	3/16	13/16	1	7/8	No. 14—24
1 5/8	9/16	3/16	13/16	1 1/4	7/8	No. 14—24
1 7/8	9/16	3/16	13/16	1 3/8	7/8	No. 14—24
5/8	5/8	3/16	1	1/2	1	5/16—18
7/8	5/8	3/16	1	5/8	1	5/16—18
1 1/4	5/8	3/16	1	1	1	5/16—18
1 5/8	5/8	3/16	1	1 1/4	1	5/16—18
2	5/8	3/16	1	1 1/2	1	5/16—18
2 3/8	5/8	3/16	1	1 3/4	1	5/16—18
3/4	11/16	1/4	1 3/16	9/16	1 1/4	3/8—16
1	11/16	1/4	1 3/16	3/4	1 1/4	3/8—16
1 3/8	11/16	1/4	1 3/16	1	1 1/4	3/8—16
1 3/4	11/16	1/4	1 3/16	1 5/16	1 1/4	3/8—16
2 1/8	11/16	1/4	1 3/16	1 5/8	1 1/4	3/8—16
2 1/2	11/16	1/4	1 3/16	1 7/8	1 1/4	3/8—16
1	3/4	1/4	1 5/16	3/4	1 3/8	7/16—14
1 3/8	3/4	1/4	1 5/16	1	1 3/8	7/16—14
1 3/4	3/4	1/4	1 5/16	1 5/16	1 3/8	7/16—14
2 1/8	3/4	1/4	1 5/16	1 5/8	1 3/8	7/16—14
2 1/2	3/4	1/4	1 5/16	1 1/4	1 3/8	7/16—14
2 7/8	3/4	1/4	1 5/16	1 7/16	1 3/8	7/16—14
1 3/8	3/4	1/4	1 5/16	1	1 1/2	1/2—13
1 3/4	3/4	1/4	1 5/16	1 5/16	1 1/2	1/2—13
2 1/8	3/4	1/4	1 5/16	1 5/8	1 1/2	1/2—13
2 1/2	3/4	1/4	1 5/16	1 1/4	1 1/2	1/2—13
2 7/8	3/4	1/4	1 5/16	1 7/16	1 1/2	1/2—13
3 1/4	3/4	1/4	1 5/16	1 5/8	1 1/2	1/2—13

Machinery

BOOKS ON AUTOMOBILES AND GAS ENGINES*

In the March number of MACHINERY a list of books on scientific management was published in reply to the many inquiries relating to books on this subject that have been received by the editor. A list of books on automobiles and gas engines is given for the benefit of readers interested in the literature relating to this important subject. These books have been recommended by experts as being the best on this subject.

Audel's Gas Engine Manual. 469 pages, 5½ by 8½ inches. Price, $2.
This is a practical treatise relating to the theory and operation of gas, gasoline, and oil engines, including chapters on producer gas plants, marine motors, and automobile engines, written in popular style.

Automobile Repairing Made Easy. By V. W. Page. 1056 pages, 5½ by 8 inches. Price, $3.
This is a comprehensive practical exposition of modern automobile repair practice, completely illustrated.

Carbureting and Combustion. By Ernest Sorel. 269 pages, 5¼ by 8 inches. Price, $3.
This book relates primarily to the carbureting and combustion in alcohol engines, but the fundamental principles relate to all fuels, and the book is recommended to those interested in the theory of carburetion and combustion.

Gas Engine Design. By C. E. Lucke. 262 pages, 6 by 9 inches. Price, $3.
This is a valuable book for designers. It is highly technical in character and is not intended as a primer for those who wish to obtain a knowledge of general principles but as a standard work for those engaged in the actual design of engines.

Gas, Gasoline and Oil Engines. By C. D. Hiscox. 476 pages, 6 by 9 inches. Price, $2.50.
This book is written in popular style, and describes in detail the parts of gas engines and their action. It is recommended for obtaining a general all-around knowledge of gas engines.

Gas Power. By C. F. Hirshfeld and T. C. Ulbricht. 209 pages, 5¼ by 8 inches. Price, $1.25.
This book treats the subject from the students' and designers' point of view; the treatment has been made as simple and unmathematical as possible, and it should be useful to those who wish to obtain a working knowledge of gas engines but who have not had the advantage of a broad technical education.

Gas Power. By F. E. Junge. 548 pages, 6 by 9 inches. Price, $5.
This book is recommended as an excellent treatise for those who want to go deeply into the subject. It deals completely with power production by means of gas engines, having especial reference to large engines.

Handbook on Gas Engines. By H. Haeder. 330 pages, 7 by 9 inches. Price, $5.
This is a translation and adaptation of a standard German handbook which contains a complete collection of data for designers and students of gas engines.

Internal Combustion Engines. By R. C. Carpenter and H. Diederichs. 612 pages, 6 by 9 inches. Price, $5.
This is a work on gas engines for those who wish to study in a complete manner the theory and general design of gas engines.

Internal Combustion Engines. By H. Guldner and H. Diederichs. 690 pages, 11 by 8½ inches. Price, $10.
This is by far the largest, most complete, and possibly one of the most authoritative of the works published on internal combustion engines. It is characterized by the authors as a handbook for designers and builders of gas and oil engines. The work is of German origin and has been translated and augmented by additions on American engines.

Internal Combustion Engines. By R. E. Mathot. 576 pages, 6 by 9 inches. Price, $6.
This work is recommended both for general study of gas engines in the various forms and types, and as a reference work for designers.

Self-propelled Vehicles. By James E. Homans. 597 pages, 5½ by 8 inches. Price, $2.
This is a popularly written book explaining the general principles involved in the design and operation of automobiles and automobile engines. It is recommended for those who wish to get a fairly non-technical description of the automobile and its mechanism.

The Gas Engine. By F. R. Hutton. 562 pages, 6 by 9 inches. Price, $4.50.
This is a popularly written treatise on the gas engine, which contains in addition a scientific treatise on the theoretical analysis of the gas engine. The work is mainly descriptive, and suitable for the average designer.

The Gasoline Automobile. By P. M. Heldt. In two parts, each about 500 pages, 5¼ by 8½ inches. Price, $4 each.
This is a complete and scientific treatise, the first part dealing with the gasoline motor, and the second with the running gear and the transmission. Ignition appliances and radiators are not dealt with, since these apparatus are the objects of special industries and are seldom built in automobile factories.

The Gasoline Automobile. By G. W. Hobbs and B. G. Elliott. 256 pages, 6 by 9 inches. Price, $2.
This book contains a series of lectures intended mainly for men who drive, repair, or sell automobiles. It explains in a popular way the mechanical principles underlying the operation of automobiles.

The Gas and Oil Engine. By Dugald Clerk. Published in two volumes. Part 1, 390 pages, 6 by 9 inches. Price, $4. Part 2, 838 pages, 6 by 9 inches. Price, $7.50.
This is both a scientific and practical treatise on gas, petrol, and oil engines, the first part dealing with the thermodynamics of these engines in a comprehensive yet not too theoretical manner; while the second part deals with the design and construction of gas and oil engines.

The Modern Gasoline Automobile. By V. W. Page, 850 pages, 5½ by 8 inches. Price, $2.50.
Of the books written on the gasoline automobile in a popular style, this is possibly the most complete. It covers practically all the devices used in connection with the automobile power generating and transmission mechanism.

The Gas Turbine. By H. H. Suplee. 262 pages, 6 by 9 inches. Price, $3.
This book is especially valuable for reference, as it places in the hands of engineers and experimenters such theoretical and practical data as are available on the solution of the problem of the gas turbine.

The Gas Turbine. By Norman Davey. 262 pages, 6 by 9 inches. Price, $4.
This is a useful work for students of the gas turbine, dealing with both the theory and practice, and giving a list of gas turbine patterns from 1856 to 1913, inclusive.

Diesel Engines. By A. P. Chalkley. 298 pages, 5½ by 8½ inches. Price, $3.
This book is recommended as a complete treatise on engines working on the Diesel principle, covering both the theory and practice, and reviewing the various types developed.

* The books given in the accompanying list are not published by the Industrial Press, but the names of the publishers will be furnished on request, or copies may be obtained from MACHINERY upon receipt of cash accompanying the order.

* * *

MONUMENT TO JOHN ERICSSON

Bills have been introduced both in the United States Senate and in the House of Representatives to provide for the erection of a suitable memorial at the nation's capital to John Ericsson. A hearing was held March 13, before the Committee of Library, House of Representatives, which has the House bill in hand, at which a number of representatives of engineering and other societies in the United States were present to urge the passage of the bill. The American Society of Mechanical Engineers was represented by C. A. V. Carlsson, Washington, D. C.; Gust. Fast, Baltimore; H. G. Gillis, Washington, D. C.; E. Oberg, New York; O. Ohlson, Waltham, Mass.; C. von Philp, Bethlehem, Pa.; and R. H. Raynal, Washington, D. C. These delegates urged the passage of the bill on behalf of the American Society of Mechanical Engineers, because of the eminent position which John Ericsson held as an engineer as well as a scientist, his name being one of the most famous in the history of engineering of the nineteenth century, and also because of the unselfish and patriotic services which he rendered to the United States by the building of the *Monitor*, which saved the nation at a time of dire need. It was urged that it was especially fitting for a memorial to be erected to so great and distinguished an engineer by a nation whose prosperity and greatness has been largely due to the engineering profession, and it was also stated that in the nation's capital there should be a statue to one of the great engineers who have rendered it signal service, as well as to the soldiers and statesmen who have won fame in the service of their country. Colonel W. C. Church, the biographer of John Ericsson, and editor of *The Army and Navy Journal*, was present and pointed out why it was the duty of the nation to honor Ericsson's memory.

* * *

SPRING MEETING OF A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers will be held in New Orleans, La., April 11-14, Hotel Grunewald, headquarters. The society is to be the guest of the local members and of the Louisiana Engineering Society. The New Orleans committee has arranged visits to points of interest and social events. It is pointed out that New Orleans is at its best in April and has many attractions for visitors. Two official excursions have been arranged, one on the river to view the dock facilities and the new cotton warehouse and one to the reclaimed lands. The technical program follows:

"Organizing for Industrial Preparedness," by Spencer Miller.

"Capacity and Economy of Multiple Evaporators," by E. W. Kerr.

"The Evolution of Low-lift Pumping Plants in the Gulf Coast Country," by William B. Gregory.

"Mechanical Equipment used in the Port of New Orleans," by William von Phul.

"Establishing a Standard of Measurement for Natural Gas in Large Quantities," by Francis P. Fisher.

"Deviation of Natural Gas from Boyle's Law," by Robert F. Earhart and Samuel S. Wyer.

"Some Experiments on Water-flow through Pipe Orifices," by Horace Judd.

"The Measurement of Viscosity and a New Form of Viscosimeter," by H. C. Hayes and G. W. Lewis.

"Dynamic Balance," by N. W. Akimoff.

"Disastrous Experiences with Large Center Crankshafts," by Louis Illmer.

"On the Transmission of Heat in Boilers," by E. R. Hedrick and E. A. Fessenden.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

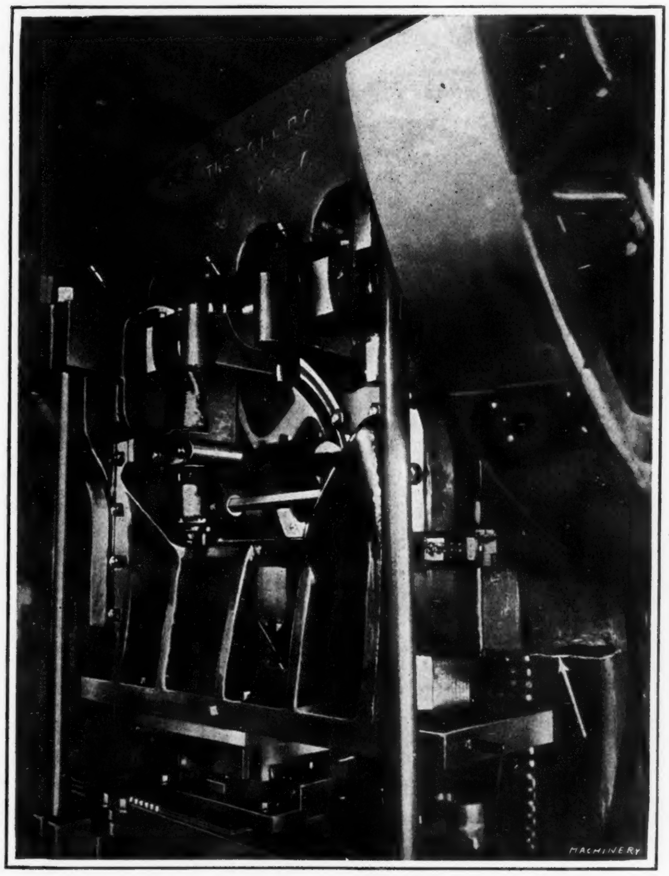
PRACTICAL APPLICATION OF OXY-ACETYLENE WELDING

The October, 1915, number of MACHINERY, which dealt largely with the subject of oxy-acetylene welding, has caused me to send the photograph and following description of a repair job we had done in our shop, which illustrates the advantages of this process. It is submitted for publication with the hope that it may be of interest to some of MACHINERY'S readers.

Last winter, we had occasion to repair a serious break in a large punch press, the capacity of which is eighty-five tons. This press developed a crack in the main frame shortly after it was purchased, as indicated by the white line in the illustration. A new frame would have cost us about $700. The Oxweld Co. of Chicago repaired it for approximately $150.

In repairing, it was necessary to dismantle the entire machine, lay it on its side, and cut away most of the frame at an angle of approximately 45 degrees in the crack. The part was heated by two blow torches to a bright red. Then the process of building it up with the oxy-acetylene flame proceeded, the time required being about twenty hours of continuous work.

After the job had cooled, the press was put back on its foundation and the main shaft, which passes through four solid bearings in the main frame, was found to fit perfectly. Every part went back into place without the slightest indication of binding. The frame of this press is stronger today than a new one would have been, because the weak part is built up with pure iron and is reinforced.

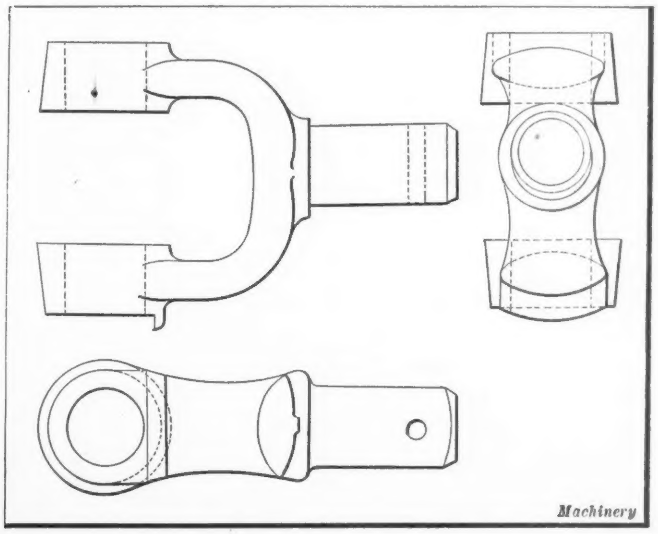


Eighty-five-ton Press, showing where Crack was repaired in Main Frame

PORTABLE ELEVATOR MFG. CO.
Bloomington, Ill. — G. B. Read, president

IS CONTINUOUS MILLING ALWAYS THE MOST RAPID METHOD?

I have noticed a growing tendency on the part of some machine tool builders and tool designers to advance the theory that continuous operation is the most rapid method of production on such work as milling. Some years ago I held the same opinion, but subsequent experience has so thoroughly demonstrated the advantages of other methods that I have been prompted to offer the following suggestions. When I receive a new part for which tools are to be designed, the most important point to be determined, from the standpoint of rapid production, is the position in which the piece must be held while finish-milling in order to secure the shortest possible feed movement; the work-holding fixture is then designed to hold the piece in this position. I have found that it is very seldom necessary to travel *across* a piece of work, for in most cases the feed may be *into* the work. For instance, take the case of the part illustrated on page 998 of the August number of MACHINERY in connection with the article entitled "Fast Continuous Milling"; with bosses 3/4 inch in diameter and a milling cutter 6 inches in diameter, it is necessary to feed 2 1/2 inches in order to pass across the work, while by feeding straight into the work a feed movement of 3/4 inch suffices.



Example of Type of Work that is milled most rapidly in Turret Fixture with Straight Feed

This method has another decided advantage which can be explained by considering the same piece. I should mount these pieces in pairs, one above the other, but by bringing the bosses close together and locating the cutters between the two parts it would be possible to mill two pieces at a time with a feed movement of 3/4 inch. The fixture employed for handling the work in this way would be made to swivel like a turret, so that work could be loaded into one side of the fixture while a cut was being taken on pieces mounted in the opposite side. Using this equipment and method, from 250 to 300 pieces could be milled per hour, and the machine and fixture employed would be less expensive than in the case where continuous milling is done.

In order to fully substantiate the claims made for this method, I will give one more example. The accompanying illustration shows a clevis which was formerly milled on four faces by the continuous process, but owing to the length of the work it was impossible to get the bosses as close together as was possible in the preceding case. The bosses were 1 1/4 inch in diameter with more than 1/4 inch of stock to be re-

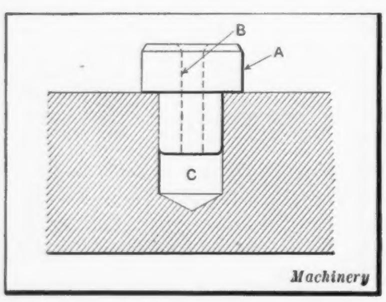
moved from each, so that it was extremely difficult to provide adequate support for the work when a rotary fixture was used. Using the continuous milling process the best rate of production attained was sixty-five pieces per hour. As this was unsatisfactory, we decided to try the swiveling turret type of fixture designed to hold two pieces on each side; the pieces were mounted side by side and two sets of cutters were provided so that both pieces were finished at a single feed movement of the table. The fixture provided ample support under each boss and the feed movement required was only $1\frac{1}{4}$ inch. Working under these conditions the rate of production was increased to 200 pieces per hour.

This principle can be applied in milling a great variety of work; it takes a shorter feed movement to complete each operation and allows the cutters to work on more than one piece at a time. The evolution of milling fixtures for handling parts of the general type referred to has been about as follows: First, the simple fixture holding one piece; second, the fixture holding a string of pieces; third, a pair of single fixtures, one mounted at each end of the table; fourth, the rotary fixture; and fifth, the swivel indexing fixture, which is the most rapid of all. The method of using a simple fixture at each end of the table is very satisfactory in many cases, but it is open to the serious objection that the loading of work into fixtures at opposite ends of the table requires the operator to walk back and forth, and this introduces the fatigue factor which materially reduces the rate of production.

Detroit, Mich. GEORGE H. CHENEY

DESIGN OF JIG FEET

A common method of making feet for drill jigs is to turn up shoulder pins somewhat like that shown at *A* in the accompanying illustration; these pins are then driven into reamed holes in the jig body. It frequently happens that jig feet are driven into blind holes, and if the feet are broken off in such holes, it is difficult to remove the broken part. To overcome this difficulty I recently made a set of jig feet similar to the one shown in the illustration, from which it will be seen that the departure from common practice consists of drilling and reaming a hole *B* through the center of each foot. Should it be necessary to remove the broken part of one of these feet from the hole, oil is poured through hole *B* to fill cavity *C* left by the drill. A short piece of drill rod, of such a size that it is a snug fit in hole *B*, is then driven in, and this rod acts like a piston, setting up pressure in the oil to force the broken foot out of the body of the jig.



Jig Foot that is easily removed if broken

New York City. DONALD BAKER

THE SQUARE CENTER

The excellent advice given by W. E. Butler in the January number of MACHINERY regarding the use of a square center in preference to a steadyrest in centering round stock reminds the writer—as it must many other "old timers"—of the days when cold-rolled steel was unknown, and when in place of drop-forgings, the machinist was required to handle in the lathe the ordinary blacksmith variety of forgings, which were not straight, round nor accurate in any other respect. In those days if a machinist received a forging of the form shown in Fig. 1, with a hub or collar near the middle which the blacksmith had made unnecessarily large, and that was so far from concentric with the rest of the work that it would not "clean up" to size if the shaft was centered at its end, the machinist put the faithful square center in the tailstock and mounted a crotch in the toolpost; the crotch was then brought up against the collar on the forging and the piece was soon centered up in this way so that it could readily be turned to the required dimensions.

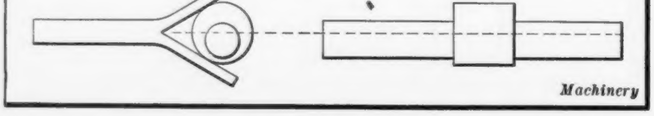


Fig. 1. Method of centering an Inaccurate Forging with a Crotch and Square Center

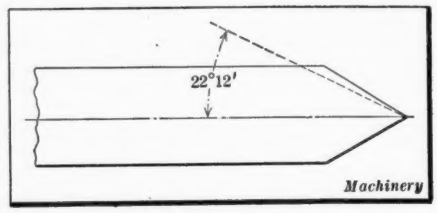


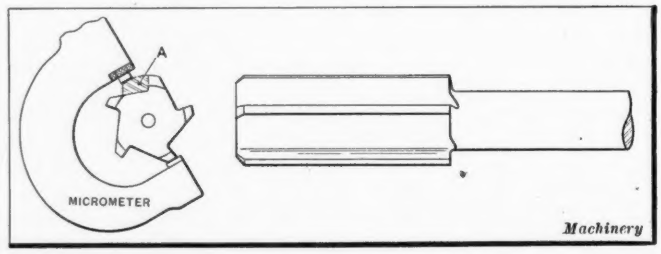
Fig. 2. Diagram showing Proper Angle to grind 60-degree Square Center

During recent years the geographical distribution of the square center is somewhat curious, as is the case with many other tools and methods of doing work. In some shops the square center is in frequent use, while in other parts of the country it is virtually unknown. In one large Eastern shop a man was employed to show from twelve to twenty lathe operators the easiest and quickest ways of doing certain classes of work, and this instructor suggested the use of the square center on such jobs as Mr. Butler mentioned. The instructor found that none of the men under his supervision had ever heard of the square center, these men having been taught to employ the steadyrest exclusively; and further investigation showed that out of about two hundred machinists there was only one who had gained any experience with the use of the tool. Some machinists prefer to make the cutting center triangular instead of four sided, believing that this is the means of obtaining a more efficient and durable edge. Either form of tool is easily made and ground if it is remembered that for a 60-degree center the proper angle to use in milling and grinding is 22 degrees, 12 minutes for the square center, and 26 degrees, 34 minutes for the triangular center.

New London, N. H. GUY H. GARDNER

CALIPERING FIVE-FLUTE REAMERS

It is sometimes desirable to make reamers or similar cutting tools with an uneven number of flutes, or with teeth that are staggered so that the spacing is unequal. However, the calipering of such tools, when grinding the diameter, is a difficult matter, because no two flutes are opposite each other, and hence a true reading of the micrometers cannot be readily obtained. The illustration shows a five-flute reamer after it has been hardened, ready to grind. A piece of brass *A* is lightly soldered into place against one of the flutes, and this is ground while the cylindrical grinding is being done, so that the calipers can be used across the brass and on the tooth at the opposite side. After the proper diameter has been reached, it is only necessary to touch the piece of brass with a hot soldering iron or to heat it slightly in order to remove the block from the flute.

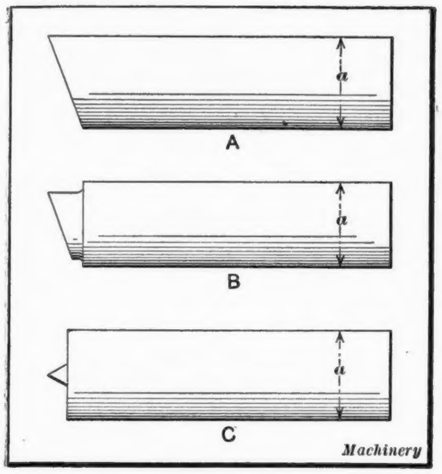


Method of calipering Five-flute Reamers

A. A. D.

PLUG SCRIBERS FOR TRANSFERRING HOLES

A handy style of plug scribers for transferring holes when attaching brackets or other parts to machines is shown in the accompanying illustration. The dimension *a* of the plugs is



Plug Scribers for transferring Holes from One Machine Part to Another

the same as the diameter of the hole to be transferred. Plug *A* is cut off at one end to an angle of about thirty degrees to form a marking point for transferring the size of the hole. Plug *B* is turned down at one end to the diameter of a tap for a screw of the size of the scriber body *a*.

The bracket is held in position against the machine and the scriber *A* or *B* (according to whether a through bolt or a screw is to be used in the hole) is inserted in the hole in the bracket and given a couple of turns, bearing against the end, so that a circle of the desired size is scribed. The plug is then removed and plug *C* is inserted and struck with a hammer, making a punch mark for starting the drill. After the holes are scribed and the punch mark is made, the bracket is removed and the holes are drilled.

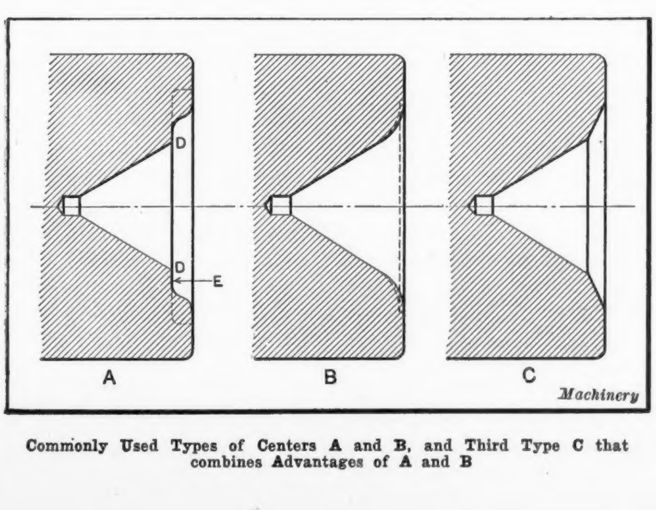
This method is quicker and more accurate than the old method of using scriber, dividers and center punch. A set of these plug scribers was made up ranging from 1/4 to 1 inch in diameter, a small flat being milled near the end on which the size was marked, and these plugs were kept in a tool-crib with the drills.

M. H. CHASE

SHAPES OF WORK CENTERS

Now that almost all centers are made with a 60-degree included angle, could we not standardize other details? Much diversity of opinion exists as to the proper size of centers for different classes of work; the chamfer is made in a variety of forms, and the drilled hole varies considerably in both diameter and depth. The writer would like to know what is the best form of chamfer. The centers shown at *A* and *B* are the ones most generally used; the type shown at *A* is the one usually found on tool-room made tools, while the type shown at *B* is employed by manufacturers of arbors and other parts that are likely to experience hard service. It would seem that type *B* is the better form from all viewpoints except that it may cost a trifle more to make; but the form of center shown at *C* is as good as either of the preceding types and costs less.

Some toolmakers prefer the form shown by dotted lines at *A*, but this design really increases the objection to this type of center in that it leaves corners *D* more exposed and increases the liability of the lathe center catching on flat surface *E* when centering the work. When the chamfer is of the form shown at *A*, there is always a possibility for a fin to be raised at *D* which will do away with the usefulness of the chamfer.



Commonly Used Types of Centers A and B, and Third Type C that combines Advantages of A and B

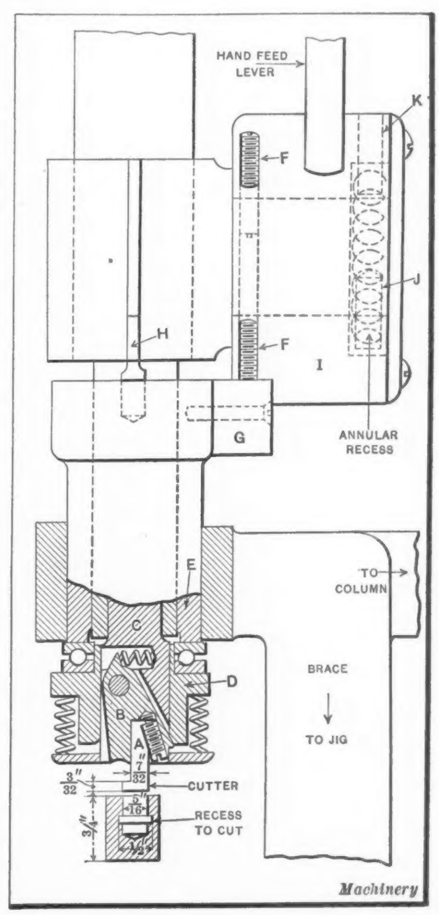
The fin is also likely to be pressed into the center. The combination countersink and drill has been much longer coming into use than is warranted by the merits of this type of tool, but now that it is fairly well established why not have a combination countersink, chamfer and drill? With such a tool, centers of the form shown at *B* could be made at a single operation, and if they occasionally came out as shown by the dotted lines no great fault could be found with the result. The types of combination countersink and drill which are at present available in the market, are provided with drills that are too long to be used conveniently. The makers probably believe that users of these tools think they are getting more for their money if they get a long drill, but if the user has had much experience with these tools he will generally reduce the length by about one-half before starting to use it. Except when working in very soft material, a long drill wastes time and is more likely to be broken than a short one.

Another phase of the subject of centers is the question of lubrication. All agree that the ideal lubricant must be heavier than oil, white or red lead being used in most cases. Practice varies in regard to cutting the oil groove; some provide the groove in the work and others in the lathe center. The latter appears to be the better practice, as a groove along the top of the dead center is always in a fixed and convenient position. The groove should be narrow and not too deep.

Wilkinsburg, Pa. WILLIAM S. ROWELL

EFFICIENT RECESSING TOOL

On a contract for some automobile parts, we were confronted with the problem of developing a method for cutting an annular recess 3/32 inch wide by 3/32 inch deep in a hole 5/16 inch in diameter. As there were 50,000 parts to be machined, the object was to develop tools which would do the work in the most inexpensive way; it was also necessary for the operation to be completed at least as rapidly as the preceding and following operations in order to avoid delay. The jig that we designed was of ordinary construction but provided with a hopper for the blanks and so arranged that a single movement of a hand-lever delivered a block to the jig and clamped it in place. The 5/16-inch hole had already been drilled in the parts before they were delivered to the hopper. The return movement of the lever discharged the block through a chute that dropped it in a suitable receiver. In this way the time of handling was reduced to a minimum.



Tool used for cutting 3/32-inch Recess in a 5/16-inch Hole

The accompanying illustration shows the cutting tool and the manner in which the feed was obtained; a few changes made on the Taylor & Fenn drill press made it possible to obtain the entire feed motion by a single movement of the hand feed lever. The cutting tool *A* is carried in a flat piece *B*

that is supported by a pivot near its upper end and held by a spring so that when the spindle is brought down the revolving tool will just enter the 5/16-inch hole. Tool *A* and swinging block *B* are carried by stem *C* which fits into the taper hole in the spindle of the drill press. The spindle stop governs the depth at which the recess is cut in the 5/16-inch hole, and the depth of the recess is determined by the tool. The method of obtaining the cross-feed of the tool is as follows: Collar *D* is a sliding fit on stem *C* and is normally held up by compression springs; but collar *D* can be pushed down by sleeve *E* which is a close fit on the outside of the spindle. The vertical movement of the sleeve on the spindle is obtained by means of screw *F*, which engages projection *G* on the sleeve, and the sleeve is prevented from rotating on the spindle by means of pin *H*. The downward movement transmitted to collar *D* causes its inner beveled edge to swing piece *B* about its pivot, and results in feeding cutter *A* into the work to cut a recess of the required depth. The difference between the recess cut by this swinging action of the tool and that which would be obtained by a straight cross-feed is practically nil. An upward movement of collar *D* and the action of the compression springs return cutter *A* to the starting position ready to be lifted out of the work.

In order to obtain this combination of movements for tool *A*, the parts of the regular hand feed mechanism were removed from the pinion shaft and a cast-iron ring *I* substituted, which has a turned recess at the outside that is covered by a plate. Two pins project into this recess, pin *J* being connected to the pinion shaft and pin *K* to the ring; there is a compression spring between the two pins. This spring permits the normal vertical movement of the spindle downward until the stop is engaged, at which point the spring is compressed while the ring is turned sufficiently to cause screw *F* to impart motion to the cross-feed mechanism. All working parts are made of hardened steel and ample provision is made for lubrication, the latter being an important matter because the machine was operated at a speed of 1500 revolutions per minute and it was necessary to obtain a fine finish on the work.

It will be noted that a brace is provided between the column of the machine and the jig, and also between the column of the machine and the sleeve surrounding the spindle at the lower end. In this way a rigid construction is obtained, and errors due to vibration are practically eliminated. The average rate of production was 100 pieces per hour, and twelve cutting tools made of carbon steel were found sufficient to complete machining the 50,000 pieces. This method offered an easy means of doing what might otherwise have been a difficult job, and the tool showed itself to be entirely fool-proof. In operation, it was merely necessary to work the left-hand lever for feeding the work into the jig, and the right-hand lever to operate the feed. The work was done at the plant of the Morgans & Wilcox Mfg. Co., Middletown, N. Y.

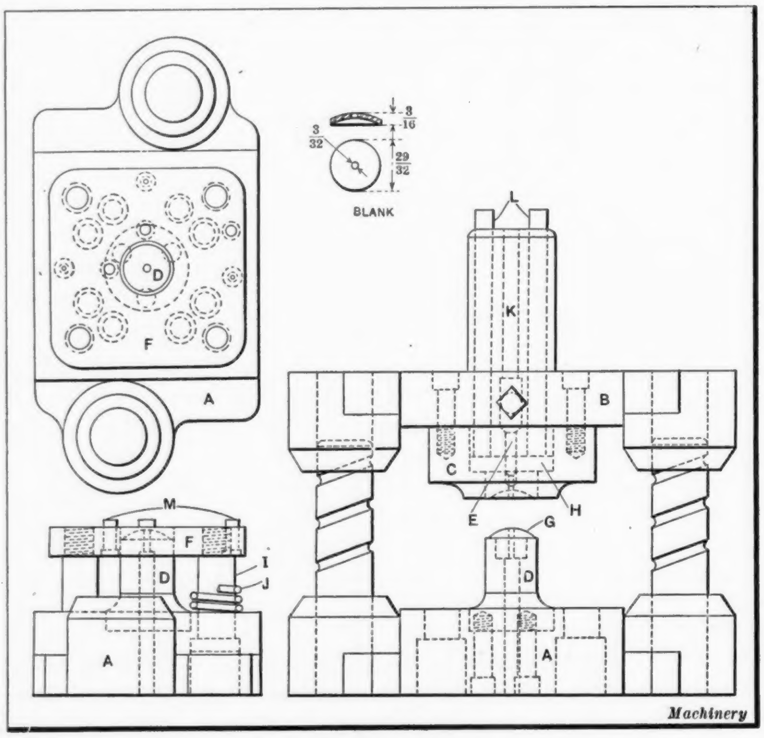
Middletown, N. Y. DONALD A. HAMPSON

PIERCING, BLANKING AND FORMING DIE

The blank shown in the accompanying illustration might be made in any one of several types of dies, but as there was a large number to be made, the writer considered the compound die shown to be best adapted for this job. The number of parts required was 50,000, which seemed to warrant the making of this style of die, as the work was completed in one stroke of the press. The stock from which the blank was made was hot-rolled steel, 0.050 inch thick by 1 inch wide. It was proved eventually that this die, hand-fed, would turn out about 15,000 blanks per day.

The die is of the pillar type, and the punch *D* is carried in what is normally the die-holder *A*, the die being carried in what is normally the punch-holder *B*. The piercing punch *E*, however, is held in its normal position in holder *B* by a set-screw, and it may be pushed out when necessary through hole *K*. The pad *F* is cut out for the punch *D* and is held a little above the top of the punch by the springs *J*, being limited in its upward travel by the headed studs *I*. On pad *F* are pins *M* which guide the stock while it is being fed over the punch.

The punch *D* is bored out to receive the former *G*, which fits it snugly. In former *G* there is a 3/32-inch hole for the piercing punch *E* to enter. Former *G* is made a separate piece so that it can be removed when grinding the die.



Compound Cupped Washer Die

The knock-out *H* is made a sliding fit in the die *C* and has a hole through its center for the punch *E*. The two pins *L* pass through the punch-holder shank and abut against the knock-out *H*. On the upward stroke of the ram the upper ends of the pins *L* come in contact with a fixed stop on the press, ejecting the blank from the die.

In operation, the stock is fed over the punch *D* and former *G*, being guided by pins *M*. As die *C* descends, contacting with the stock, pad *F* descends until the stock is forced against the top of former *G*, when the stock is cupped over former *G* and the cup is blanked out. While the cup is being blanked, punch *E* pierces the 3/32-inch center hole.

The knock-out *H* is cut out on its face to fit the contour of the cup when formed, but this in no way assists the process of cupping the blank. It is simply for ejecting the finished cup from the die. This knock-out virtually floats in its position in die *C*. It might have been better design to have made the face of the knock-out *H* come about 3/16 inch below the face of the die *C*, but as no trouble was experienced in this respect it was made as shown. In other respects this die was made according to ordinarily accepted design.

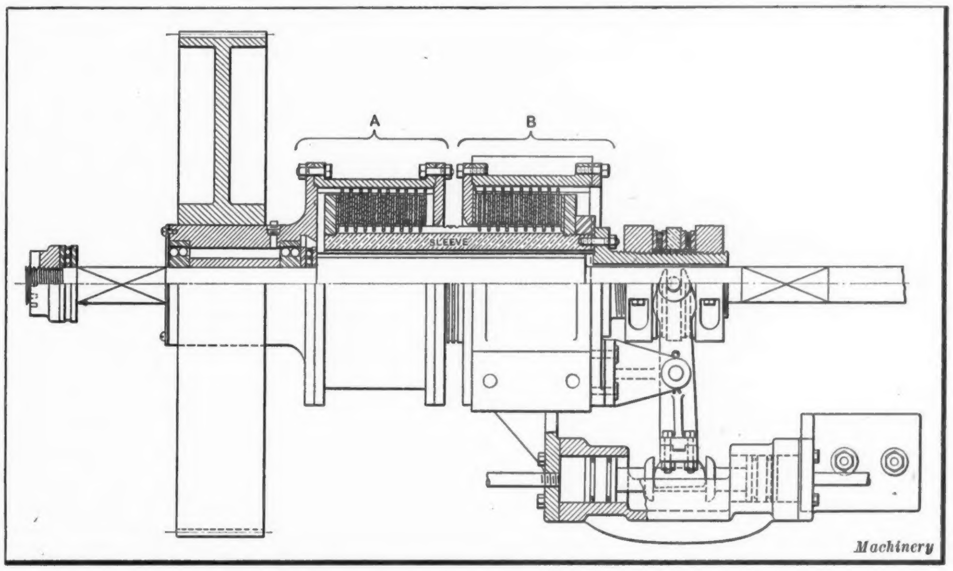
Chicago, Ill. A. H. WILSON

EFFECTIVE CLUTCH MECHANISM

It is sometimes necessary to start and stop machines or certain parts of machines smoothly, with great rapidity, and in synchronism with other moving parts. With light or slow moving apparatus the problem is relatively simple, but the difficulties multiply as weight and speed are increased. The clutch mechanism here described has shown such an unusually efficient and consistent performance during a period exceeding two years, that it is of more than passing interest. One of these machines has been transmitting a load of twenty horsepower, operating about 3600 times per day, under unusually trying conditions, with practically no trouble of any kind except a broken shaft which was found to be due to an imper-

fect forging. This machine picks up its load from dead rest, makes three revolutions and comes to rest again in three-fifths second, or at an average rate of 300 revolutions per minute, without the slightest shock or effort. When it is considered that the clutch drum is driven at only 340 revolutions per minute, and the engagement is only a fraction of a second, it will be seen that the slip is very slight indeed. The absence of shock may be attributed to the perfect cushioning of the pressure applied to the clutch and to the liberal friction area provided, there being close to a square inch for each pound of pull at the average radius of the disks.

The device consists essentially of two multiple disk friction clutches of the dry type mounted tandem on a single sleeve which is fitted to slide but not to turn on a shaft that is directly coupled to the intermittent load. The general construction of the two clutches is shown in the accompanying illustration, in which *A* is the driving clutch, and *B* the brake clutch. The two clutches are built up in the usual form for disk clutches, that is, with two alternate series of disks, one keyed to the driving member and the other to the driven member; one set is preferably faced with friction fabric. One type of disk is provided with internal projections to engage longitudinal slots on the sleeve, while the other disks have external projections loosely fitting the internal slots of the driving and braking clutch drums. The projecting lugs on the disks are reinforced to provide greater bearing surface on the sides of the slots in which they travel. As both clutches are mounted on the same sleeve, and the outer part of the driving clutch is continuously driven, the sleeve becomes the driven member of the driving clutch and the driving member of the brake clutch. The driven member of the brake clutch is solidly bolted to the frame of the machine of which the clutch constitutes a part, so that in reality it is not driven, but acts as a brake to bring the sleeve to rest when this clutch is engaged.



Design of Quick-acting Friction Clutch, operated by Air Pressure

The shaft, which is mounted on two bearings as indicated, is square, for convenience, where it carries the clutch sleeve. Both the clutch drums are built in skeleton form to facilitate the egress of material wearing off the friction facings, and to permit of the easy application of castor oil to the facings. If this treatment is not neglected, a set of facings may be expected to last two years or more in constant service, but if the facings are allowed to become entirely dry their life will be much shorter. It will be seen that the sleeve is provided with a flange on each end so that when it is moved endwise the disks of one of the clutches will be clamped between one of the sleeve flanges and the head of one of the clutch drums, while the pressure on the disks of the other clutch will be released. Movement of the sleeve in the opposite direction will release the disks of the first clutch and clamp those of the second. In the illustration the parts are shown in the position of rest, or with the driving clutch disengaged and the brake clutch set.

The novel part of the device is the controlling mechanism, which is operated pneumatically and may be made automatic by connecting with other moving parts to actuate the valves. It will be seen that the actual movement of the sleeve which engages and disengages the clutches is accomplished by two opposed pneumatic cylinders and the connections shown. It will be apparent that the cylinders must work alternately, that is, when one is under pressure the other must be open or free to exhaust. The distribution of air is controlled by two valves, together with a series of interconnecting pipes. With the valves in the "up" position, compressed air is free to pass through the pipe to one of the cylinders, and to the top of the other valve. This latter connection is for the purpose of forcing the other valve down, cutting off the air supply of the cylinder it serves, and opening it to exhaust. It also leaves the valve in position for further action.

A small hole near the live air inlet leads to the annular space below the valve proper, around the stem, and is open continuously, admitting air to hold the valve in the "up" position when so placed. As the only connections between the controlling valves and the cylinders are pipes, the control may be somewhat remote and placed in any convenient position. Experiments have been made to determine the practicability of operating the valves magnetically, and also of moving the clutch sleeve by means of magnets, but both have been found far less efficient and much slower than air, the slowness of the electrical operation being due to the time required for the magnets to "build up." The drift of the shaft after the operation of the stopping valve has been found to be very small and practically constant, the shaft stopping within a few degrees of the same position every time. It will be noted that any wear on the friction disks or their facings is automatically compensated for by additional travel of the pneumatic pistons, so that mechanical adjustments are rarely required.

Youngstown, Ohio. H. E. White

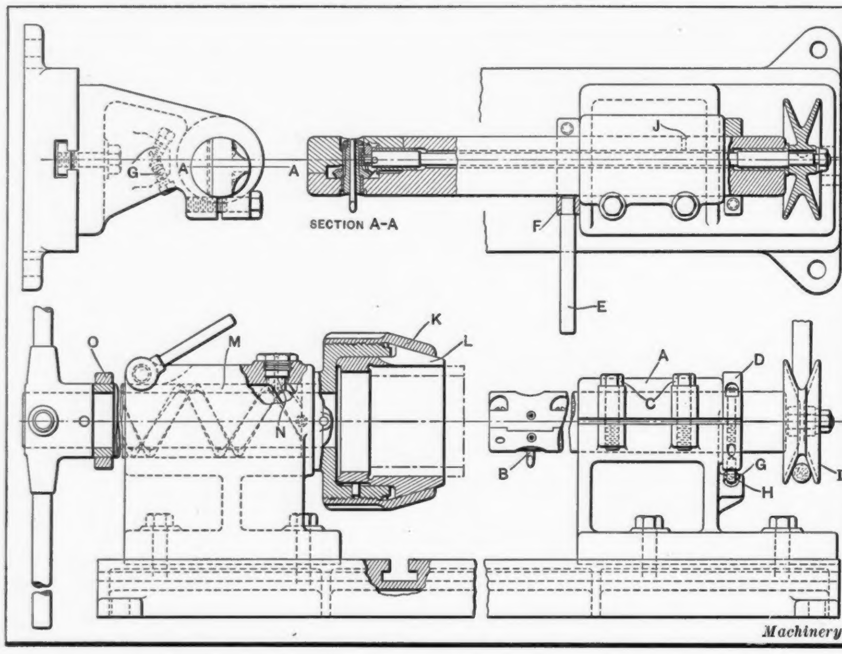
OIL GROOVING FIXTURE

We had a large number of different sizes of bearing liners in which it was necessary to machine oil grooves, and as it was required to have these cut quite accurately it was decided to construct a fixture which would enable the work to be done as rapidly as possible. The device is shown in the accompanying illustration, in which it will be seen that there is a cutter-head *A* carrying a spindle which supports cutter *B*. The position of the spindle may be adjusted to suit the length of bearing liner which is to be grooved, and after the spindle has been set in the required position it is clamped by tightening the nuts *C*, after which collar *D* is set up against the back of the cutter-head to provide for resetting the spindle in the same position for grooving each of the bearing liners.

The cutter-spindle is 1/16 inch out of alignment with the work-spindle, and by releasing screws *C* and revolving the cutter-spindle by means of pin *E* inserted in collar *F*, cutter *B* may be set to obtain the required depth of cut or to clear the work when it is necessary to withdraw the cutter-spindle in order to substitute a fresh blank. Screws *G* are so adjusted in relation to pin *H* that they limit the rotary motion of the cutter-spindle so that cutter *B* is either set to work at the required depth or to entirely clear the work, as the case may be.

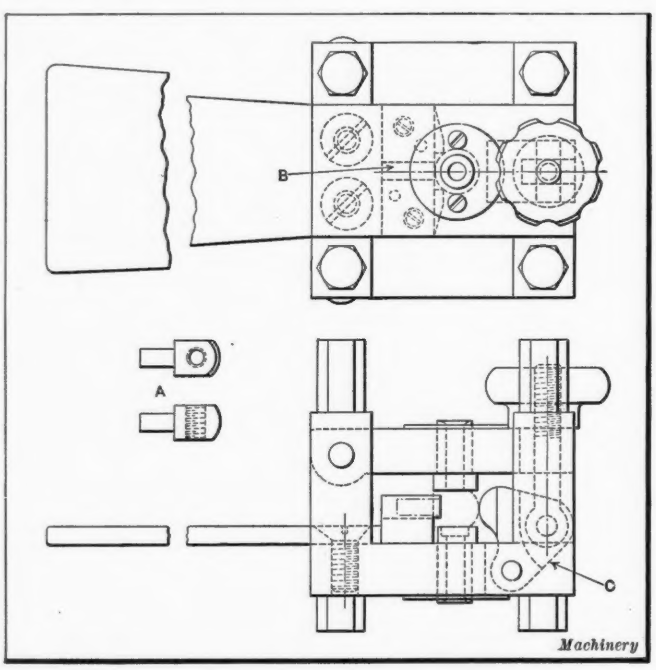
It will be evident from the illustration that cutter *B* is carried by an auxiliary spindle contained within the main spindle

of the cutter-head, and that this spindle is rotated by a round belt carried on pulley *I*, from which motion is transmitted to the cutter through the auxiliary spindle and a pair of bevel gears. The auxiliary spindle runs in hardened and ground bushings at each end of the main spindle in the cutter-head, and lubricant is supplied through oil hole *J*, from which it is distributed to all parts that are housed in the main spindle. All rotary parts are provided with oil grooves to facilitate lubrication. The cutter, of the two-lip round-nose form, is made of high-speed steel.



Oil Grooving Fixture for machining Bearing Liners of Various Lengths and Diameters

The work is held in chuck *K* by means of a spring collet *L*, and collets of various sizes are provided to hold the different sizes of bushings which have to be machined. In some cases it was found advisable to employ split bushings inside the collets for use in handling some of the bushings, and this method gave very satisfactory results. At the back of the work-spindle there is a capstan wheel by which the spindle is rotated. It will be seen that bushing *M* has a spiral groove cut in it of the same lead as the oil groove which it is required to machine in the bearing liner, and pin *N* fits into this groove so that when the capstan wheel is turned it results in feeding the spindle and work forward so that the oil groove will be cut in the bearing liner. It will be evident from the illustration that the forward movement of the spindle is limited by an adjustable collar *O*, which is set to give the required travel to the work-spindle. G. E. P.



Jig in which a Single Screw tightens both Clamp and Hinged Cover

JIG FOR DRILLING SMALL STUDS

The jig here described is used for drilling and tapping stud *A*, which is made from ¼ by ¼ inch cold-drawn steel. The end of the stud enters hole *B* in the locating block, and this hole is milled to provide clearance for the head of the stud. The work rests on the drill bushing which is slightly counterbored to provide clearance for the tap. The most interesting feature of the jig is that the cover and clamping mechanism are both secured by the same knob; clamp *C* holds the stud securely in place when the knob is screwed down, and the same operation tightens the cover. It will be readily seen that this principle could be employed on jigs and fixtures used for holding a great variety of parts.

JOHN HOFFMAN

ACCURACY IN PLANING LONG WORK

The writer was recently given six parallels to plane, which were 5 inches by 5 inches by 6 feet in size. The sides were required to be perfectly straight and parallel. In handling the work the first step was to rough out the pieces, leaving 1/16 inch on each side for finishing. A light cut was then taken over the planer table to insure having it parallel with the cross-rail of the machine.

The first attempt to do the work was made on a planer with a table travel of six feet, but the results obtained were unsatisfactory. The work was finally taken to a planer with a table travel of twenty feet, and on this machine little trouble was experienced.

The cause of the trouble on the short machine was due to the fact that the table had considerable over-hang at each end, with the result that the ways had worn down and caused it to tilt at both extremes of its stroke, as shown by the dotted lines in the illustration. This condition was made worse by the fact that at the points of reversal the driving gear tends to lift the table. But on the long-stroke machine, where the work could be handled without bringing the table near either extremity of its travel, no trouble was experienced in producing accurate work.

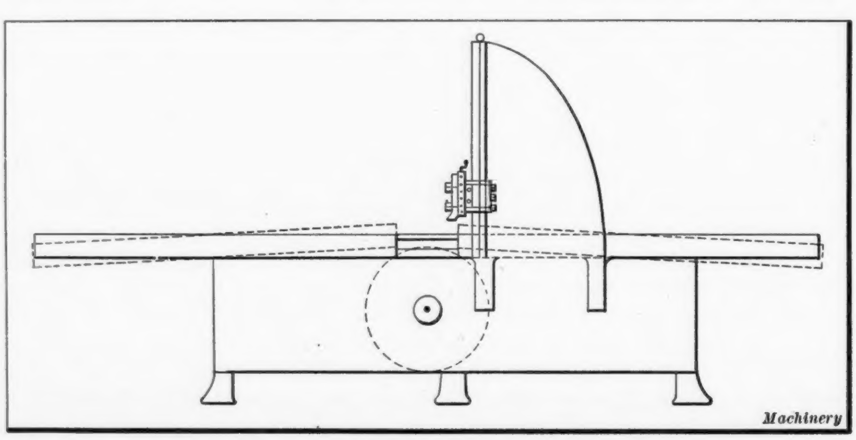


Diagram showing how Ends of Planer Ways became Worn, making it Difficult to plane Long Work and obtain Accurate Results

W. E. BUTLER
Wausaukee, Wis.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TO FIND THE VALUE OF X IN EQUATION

F. E. R.—Please show how to find the value of x to one decimal place in the equation $(1-a)^x = \frac{c - as}{c}$, when $a = 0.02$, $c = 86$, and $s = 1550$.

A.—The easiest way of solving this equation is by the use of logarithms. Substituting the values given, and taking the logarithm of both sides, $x \log (1 - 0.02) = \log \frac{86 - 0.02 \times 1550}{86}$. Reducing, $x \log 0.98 = \log \frac{55}{86}$. Using a five-place table, $\log 0.98 = \bar{1}.99123 = -0.00877$; $\log 55 = 1.74036$, $\log 86 = 1.93450$, and $\log \frac{55}{86} = \log 55 - \log 86 = 1.74036 - 1.93450 = -0.19414$. Therefore, $-0.00877\ x = -0.19414$, and $x = \frac{0.19414}{0.00877} = 22.13+$, or 22.1 to one decimal place. J. J.

TO DETERMINE CAPACITY OF CYLINDRICAL TANK

H. V. P.—Please give a rough-and-ready rule for finding the number of gallons that a cylindrical tank with flat ends will hold.

A.—Let d = diameter in inches; l = length in inches; L = length in feet; and G = number of gallons. Then, $G = \frac{0.7854\ d^2l}{231} = 0.0034\ d^2l = 0.0034\ d^2 \times 12\ L = 0.0408\ d^2L = 0.04\ d^2L$ approximately $= \frac{(2d)^2\ L}{100}$. Hence, for a rough-and-ready rule: Double the diameter in inches, square the result, multiply by the length in feet, and divide by 100. If an accurate result is desired, add 2 per cent of the result obtained by the rule. As an example, suppose that the tank is 60 inches in diameter and 18 feet long. Doubling the diameter gives 120; $120^2 = 14{,}400$; $14{,}400 \times 18 = 259{,}200$; dividing by 100 by pointing off two decimal places, the number of gallons is 2592, approximately. Two per cent of this is $2592 \times 0.02 = 51.84$, and $2592 + 51.84 = 2643.84$ gallons, the same result as would be obtained by substitution in the formula. J. J.

DISTINCTION BETWEEN MASS AND WEIGHT

W. G. C.—What is the difference between the mass of a body and its weight?

A.—Mass is an absolute unit; it measures the amount of matter in a body. Weight, on the contrary, is a measure of the earth's attraction (commonly called gravity) on a body. So long as the amount of matter in a body is not changed, its mass remains unaltered; its weight, however, may change very materially, depending on the latitude of the place where the body is weighed, the altitude (distance above or below sea level), and the temperature and barometric pressure, if weighed in air. If weighed in air under the same conditions, two bodies may weigh alike and still have different masses. For instance, a pound of iron and a pound of wood, both having been weighed in air at the same instant, have different masses, the pound of wood containing more matter than the pound of iron. The wood would weigh more than the iron in a vacuum. The reason the two weigh the same in air is that the wood has a greater volume; this causes it to displace more air than the iron, the result being that it is buoyed up more than the iron. The effect is the same, though not so marked, as if both had been placed in water. The effect of a force in changing the velocity of a moving body depends solely upon the mass; it is independent of the weight of the body. J. J.

TO DETERMINE WEIGHT OF AIR

W. J. W.—How do you find the weight of air at any temperature and pressure?

A.—For all ordinary temperatures and pressures that occur in practice,

$$w = \frac{pV}{0.37\,T}$$

in which w = weight of air in pounds;
p = absolute pressure in pounds per square inch;
V = volume of air in cubic feet;
T = absolute temperature, degrees F.

The absolute pressure is equal to the gage pressure plus the atmospheric pressure as determined by the barometer. For practical purposes, it is sufficient to add 14.7 to the gage pressure. The absolute temperature is obtained by adding 460 to the temperature indicated by the thermometer. As an example, if a cylindrical space is filled with air having a gage pressure of 58 pounds per square inch, a temperature of 118 degrees F., and the space is 80 inches in diameter and 15 inches long, $p = 58 + 14.7 = 72.7$, $V = \frac{0.7854 \times 80^2 \times 15}{1728} = 43.633$ cubic feet, and $T = 118 + 460 = 578$. The weight of the air is $w = \frac{72.7 \times 43.633}{0.37 \times 578} = 14.833$ pounds. J. J.

RELATIVE MOTION OF TOP AND CENTER OF WHEEL

H. D. P.—I have seen it stated that the top of a rolling wheel moves twice as fast as its center; does it?

A.—It certainly does. If by top of the wheel is meant the point which at any instant is diametrically opposite the point of contact with the ground. The center of the wheel has only one motion, that of translation (*i. e.*, motion in a straight line) and its direction is parallel to the ground. The top of the wheel has not only this motion of translation but also an equal one of rotation about the center. Or the entire wheel

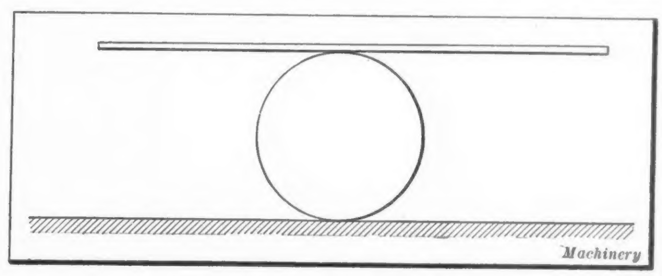


Diagram illustrating Relative Motion of Top and Center of Wheel

may be considered as rotating about the point of contact with the ground, in which case the top, being twice as far from the ground as the center, moves twice as fast. The point is well illustrated by placing a board on top of a roller, as shown in the illustration. On pushing the board (assuming that there is no slip) both the board and roller will move ahead. If the length of the board is, say, 16 feet, it will be found to have traveled its entire length while the center of the roller was moving 8 feet. As the board is in constant contact with the roller, this proves that the top moves twice as fast as the center. J. J.

RELATIVE FORCE REQUIRED TO PUSH AND PULL A WHEELBARROW

E. F. C.—Why is it easier to pull a wheelbarrow than it is to push it?

A.—There would be no difference on a level surface if the force (push or pull) were exerted in a horizontal direction.

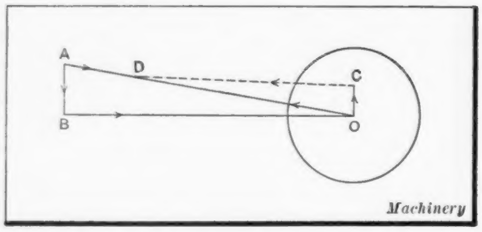


Illustration showing Forces required to push and pull Wheelbarrow

Referring to the diagram, assume that the line AO represents the center line of one of the handles, and assume further that its length represents to some scale the magnitude of the force exerted at a particular instant. If the force is a push, its direction is from A to O, and it may be resolved into two forces, one AB acting vertically downward and the other BO acting horizontally from B toward O. Since AB is perpendicular to BO, it exerts no influence whatever on BO, and BO represents to the same scale as AO the magnitude of the force tending to push the wheelbarrow ahead. AB, on the contrary, represents a force acting downward at the point O, and adds just so much additional weight to be moved. If the force is a pull, the direction is from O to A, and may be represented by OD; this force may be resolved into two forces, one OC acting vertically upward and the other CD acting horizontally from O. Since OC acts vertically upward through O, it counteracts just that much of the weight moved; hence, OD is less than AO, the load moved when pushing being greater than the load moved when pulling by an amount represented by $AB + OC$. J. J.

HORSEPOWER-HOUR DEFINED

D. G.—What is a horsepower-hour? Please explain fully.

A.—The unit of work is the foot-pound; it is equivalent to overcoming a resistance of 1 pound through a distance (space) of 1 foot. The simplest example is the lifting of a weight of 1 pound vertically 1 foot, the resistance in this case being the pull of gravity on the weight. It should be noted particularly that time is not considered. It makes no difference whether the weight of 1 pound is raised 1 foot in 1 second or in 1 year, the work done is 1 foot-pound. Hence, if a weight of 225 pounds falls a distance of 16 feet, the work it could do would be $225 \times 16 = 3600$ foot-pounds. Power, on the contrary, is the rate of doing work, and time is always considered. The unit of power is 1 foot-pound of work performed in 1 second. If the resistance in pounds be represented by r, the distance (space) in feet through which the resistance is overcome by s, the time in seconds during which the work is done by t, and the number of power units developed by p, $p = \frac{r \times s}{t}$. One horsepower is 550 power units; hence, dividing both sides of the equation by 550, $\frac{p}{550} = \text{H. P.} = \frac{rs}{550\,t}$. Dividing both terms of the fraction by 60, $\text{H. P.} = \frac{rs \div 60}{550\,(t \div 60)}$. But the time in seconds divided by 60 is the time in minutes, and letting $t \div 60 = T$, $\text{H. P.} = \frac{rs}{60 \times 550\,T} = \frac{rs}{33{,}000\,T}$. Dividing both terms of the last fraction by 60, $\text{H. P.} = \frac{rs \div 60}{33{,}000\,(T \div 60)}$. But the time in minutes divided by 60 is the time in hours; hence, letting $T \div 60 = T_1$, $\text{H. P.} = \frac{rs}{60 \times 33{,}000\,T_1} = \frac{rs}{1{,}980{,}000\,T_1}$. In other words, when $T_1 = 1$ hour, the product rs must equal 1,980,000 for H. P. to equal 1; and since rs is the number of foot-pounds of work performed, a horsepower-hour is 1,980,000 foot-pounds of work performed in one hour. Note that horsepower-hour is a unit of work and not a unit of power. J. J.

CALCULATION OF PARTIAL PAYMENTS

B. D.—In order to buy out a business, it is necessary to incur a debt of $\$5000$. The creditor is willing to accept equal monthly payments at an annual interest rate of $5\frac{1}{2}$ per cent, provided the debt is paid, together with the interest, in not over eight years. How much must be paid monthly?

A.—Let p = principal;
r = rate of interest for one of the equal intervals;
n = number of payments, or number of intervals;
x = amount paid at end of each interval.

Then, by the United States rule for partial payments,

$$x = \frac{pr(1+r)^n}{(1+r)^n - 1} = \frac{pr}{1 - \dfrac{1}{(1+r)^n}}$$

In the present case, $p = \$5000$, $r = 0.05\frac{1}{2} \div 12 = \frac{11}{2400}$, and $n = 8 \times 12 = 96$, since the interval is one month. Substituting in the formula, and noting that $1 + r = 1 + \frac{11}{2400} = \frac{2411}{2400}$,

$$x = \frac{5000 \times \dfrac{11}{2400}}{1 - \left(\dfrac{2400}{2411}\right)^{96}} = \$64.496$$

Assuming that $\$65$ is paid each month, the debt will be cleared off in n months. Solving the formula for n,

$$n = \frac{\log\left(\dfrac{x}{x - pr}\right)}{\log\,(1+r)} = \frac{\log\left(\dfrac{65}{65 - 5000 \times \dfrac{11}{2400}}\right)}{\log\left(\dfrac{2411}{2400}\right)} = 95.067 \text{ mos.}$$

Six-place logarithms were used in these solutions. J. J.

METHODS OF CHECKING MULTIPLICATION

N. R. M.—I have a great deal of multiplying to do. Is there any safe method of determining whether the product is correct or not without repeating the work?

A.—The method ordinarily used is that of casting out 9's. This is effected by dividing the multiplicand and multiplier by 9 and noting the remainders, which are then multiplied together and divided by 9; if the remainder thus obtained is the same as the remainder obtained by dividing the product by 9, the work is probably correct; but if it is not, the work is wrong. Thus, $7854 \times 2905 = 22{,}815{,}870$. Here $7854 \div 9$ gives a remainder of 6; $2905 \div 9$ gives a remainder of 7; $6 \times 7 = 42$, and $42 \div 9$ gives a remainder of 6; $22{,}815{,}870 \div 9$ gives a remainder of 6, and the work is probably correct. This test is not always certain, since the remainder when dividing by 9 may always be obtained by adding the digits, then adding the digits of the sum, etc., until a single figure is obtained; hence, if one or more mistakes are made whereby the sum of the digits (reduced to a single figure) is unchanged, the test fails. Thus, the remainders obtained by dividing the foregoing numbers by 9 are, respectively, $7 + 8 + 5 + 4 = 24$, and $2 + 4 = 6$; $2 + 9 + 5 = 16$, and $1 + 6 = 7$; $4 + 2 = 6$; and $2 + 2 + 8 + 1 + 5 + 8 + 7 = 33$, and $3 + 3 = 6$. If the product obtained had been 22,815,780, 23,805,870, 22,814,970, or any one of numerous other combinations in which the sum of the digits when reduced to one figure is 6, it is evident that the test would fail. When adding the digits, no 9's or figure combinations that obviously make 9 should be added. In 7854, $5 + 4$ obviously make 9; hence, say $7 + 8 = 15$, and $1 + 5 = 6$. In 22,815,870, $8 + 1$ is obviously 9; hence, say $2 + 2 + 5 = 9$, and reject it; then say $8 + 7 = 15$, and $1 + 5 = 6$. A much better test, and one that is practically certain, is to divide by 7. Thus, $7854 \div 7$ gives a remainder of 0; here without proceeding further it is known at once that the product when divided by 7 must give a remainder 0, since one of the factors being a multiple of 7, the product is a multiple of 7. Dividing 22,815,870 by 7, the remainder is 0, showing that the work is correct. Consider the product $7853 \times 2904 = 22{,}805{,}112$. Here $7853 \div 7$ gives a remainder of 6; $2904 \div 7$ gives a remainder of 6; $6 \times 6 = 36$, and $36 \div 7$ gives a remainder of 1. Since $22{,}805{,}112 \div 7$ gives a remainder of 1, the work is correct. The reader should apply the 7 test to the preceding numbers that were apparently correct by the 9 test, but were wrong in reality. J. J.

ROOT & VAN DERVOORT LINE OF SHELL MACHINERY

This line of special machinery for use in performing various machining operations on shells has been developed to give satisfactory service under the unusually severe conditions which exist in munition factories. In working out the designs, each machine has been made as simple as possible because it is realized that the scarcity of experienced machine operators will make it necessary to employ much unskilled labor. It will be noticed that the designs of all machines have been standardized as far as possible, and the most noticeable features are simplicity of design combined with exceptionally heavy construction.

The Root & Van Dervoort Engineering Co., East Moline, Ill., has designed a line of special machinery for use in the manufacture of 6-inch, 8-inch and 9.2-inch howitzer shells. These are single-purpose machines which are constructed on exceptionally heavy lines to adapt them for the severe service required of machines used in munition making factories; and as the design of each machine has been simplified as far as possible, it takes only a short time to teach a man possessing some mechanical knowledge how to operate these machines. Naturally this is an important matter in factories which are building up an organization to turn out a large shell order which must be completed by a specified time, and on which there is likely to be a bonus for completion ahead of the date called for in the contract.

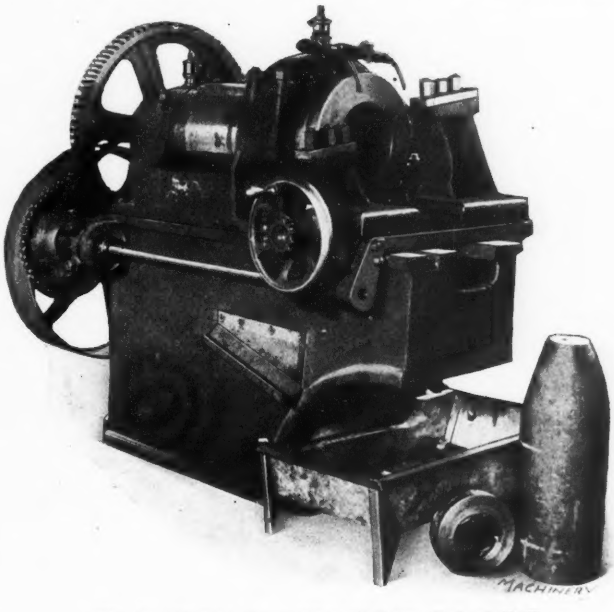


Fig. 1. Machine for cutting off Large End of Shell

This line of shell manufacturing machinery includes machines for performing the following operations: (1) cutting off; (2) rough- and finish-turning; (3) boring; (4) finishing nose of shell; (5) machining band groove, and facing end of shell to reduce it to standard weight; and (6) turning copper rifling band to required form. It will be seen from the illustrations that the design of all these machines follows the same general lines, although certain details have been varied to meet the requirements of special operations for which the different machines are intended. The most conspicuous features are the exceptionally heavy construction and the simplicity of design. Having been designed with special reference to the work for which they are intended, these machines are capable of giving highly satisfactory results, both as regards their rate of production and the quality of the finish which it is possible to obtain on the shells.

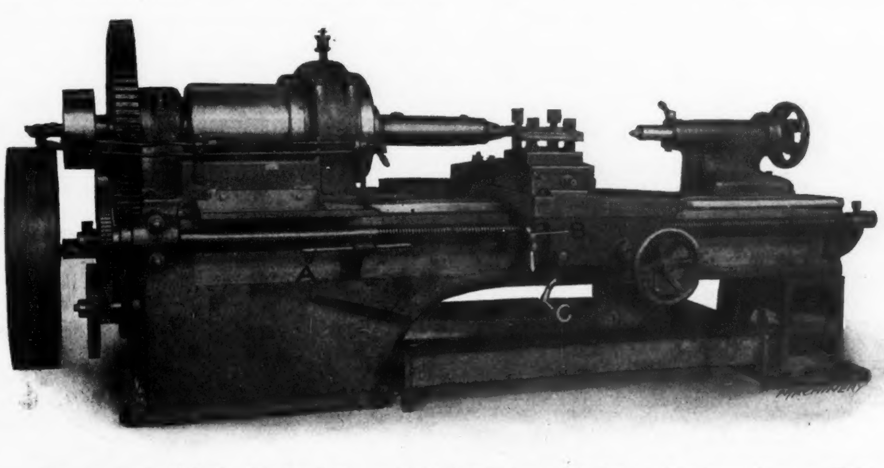


Fig. 2. Type of Lathe developed for performing Rough- and Finish-turning Operations on High-explosive Shells

Cutting-off Machine

Fig. 1 shows the cutting-off machine which is employed for removing the excess metal from the open end of the shell. As in all the Root & Van Dervoort machines, the spindle is made of semi-steel and is of exceptionally large size. It is 32¾ inches long, and is supported by a front bearing 14 inches in diameter by 8¾ inches long and a rear bearing 7 inches in diameter by 7 inches long. The bearings are babbitted, hammered and scraped to fit the spindle which is hollow, the hole being 12 inches in diameter. Longitudinal adjustment of the spindle is afforded by a lock ring located immediately behind the front bearing. The shells have been drilled through the nose and the nose has been faced at the time they are delivered to the cutting-off machine. To provide for performing the cutting-off operation, the shell is centered in the spindle from the drilled hole in the nose and its longitudinal position is located by the faced end of the nose. The open end of the shell is clamped by four screws which extend through the hollow spindle.

The machine is driven by a constant-speed single pulley, 30 inches in diameter, which carries an 8-inch double belt. From this pulley the power is transmitted through gears which are 3 inches face width and 3 pitch. Motion for the cross-feed of the cutting-off tools is provided by a roller chain which runs over a sprocket bolted direct to the gear on the spindle and drives a feed-rod located at the front of the machine; this rod transmits the power to the cross-feed screw which governs the movement of the slide carrying the cutting-off tools. These tools are ⅜ inch wide and provide for cutting to a maximum depth of 4 inches. In Fig. 1 one of the shells is shown standing by the machine, and the crop end which has been cut off from this shell is shown on the floor beside it. The average rate of production on 8-inch shells is sixteen per hour; the cutting speed is 52 feet per minute, and the feed, 1/32 inch per revolution.

Rough- and Finish-turning Lathes

The lathe shown in Fig. 2 was developed for performing the rough- and finish-turning operations on 8-inch and 9.2-inch high-explosive shells. Comparing the design of this machine with that of the cutting-off machine shown in Fig. 1, it will be seen that the bed is the same in both cases except that the bed of the turning lathe is longer and provided

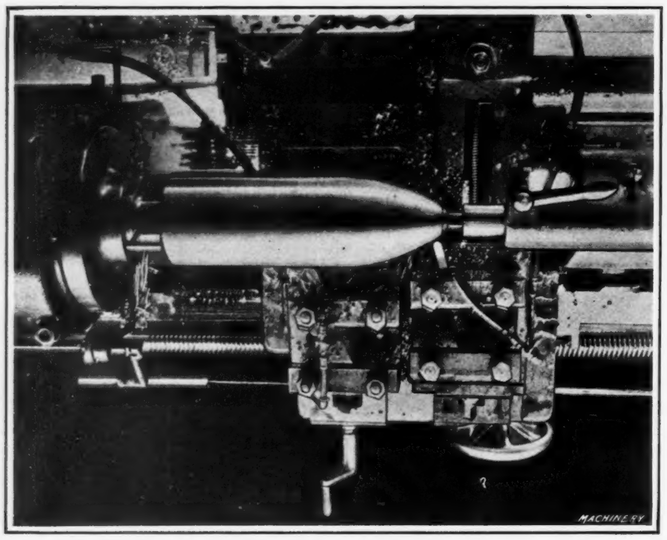


Fig. 3. Close View of Tools used for performing Rough-turning Operation

with a pedestal to support it at the tailstock end. In this respect, the cutting-off machine and turning lathe represent the two typical forms of bed construction employed in all the Root & Van Dervoort machines. As in the case of the cutting-off machine, the drive for the turning lathe is provided by a 30-inch single pulley which carries an 8-inch double belt. The spindle is also of similar design, except that it has an expanding mandrel bolted to its face which is operated by a Hannifin air chuck, instead of having the end of the spindle open as in the case of the cutting-off machine. The end of the mandrel on the turning lathe carries a bearing that extends through the 1 11/16-inch hole which was drilled in the nose of the shell at the first operation. This bearing is centered to receive the tailstock center, and provides ample support for the work while the turning operation is being performed.

It has been mentioned that this type of lathe is used for both rough- and finish-turning operations, but the design of the carriage on the machines used for these two operations is slightly different. On the machine used for rough-turning, the carriage is made exceptionally wide and is fitted with two toolposts. The tool in one of these posts turns the straight wall of the shell; the second toolpost is carried on a slide that is guided by two rollers which run in contact with a formed plate at the back of the

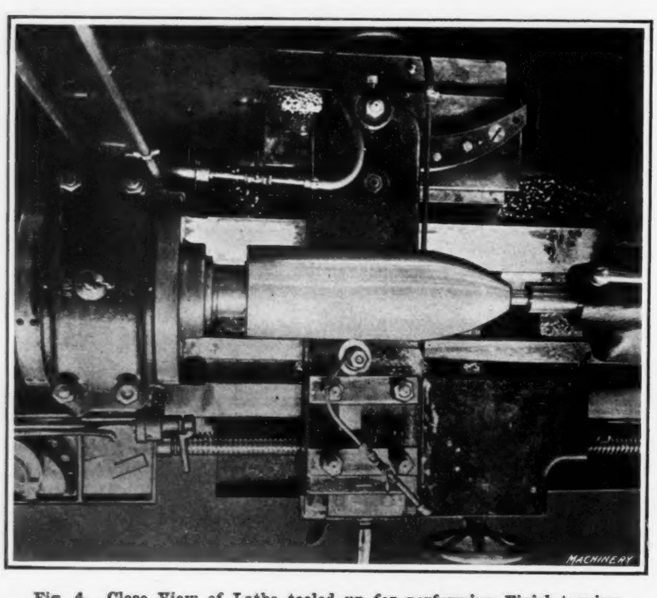


Fig. 4. Close View of Lathe tooled up for performing Finish-turning Operation

lathe bed, and the transverse movement of the tool afforded in this way provides for rough-turning the nose of the shell to the desired shape. In performing the finish-turning operation, the carriage is provided with a single toolpost which supports a circular high-speed steel tool. The transverse position of the slide that carries this toolpost is governed by a formed plate which extends the entire length of the shell. This plate is the same shape as the shell so that the finish-turning operation can be done at a single traverse of the carriage. Fig. 3 shows the lathe tooled up for rough-turning, and Fig. 4 shows a machine used for performing the finish-turning operation.

The method of chucking provides for eliminating all eccentricity of the forging by the roughing operation, so that the bore is brought concentric with the outside of the shell. An automatic trip throws the feed out when the turning operation has been completed. For this purpose a bracket *A*, Fig. 2, is bolted to the bed of the machine, and this carries an adjustable rod which engages lock lever *B* when the turning operation has been completed. Engagement of rod *A* and lever *B* results in allowing lock-nut lever *C* to fall and open the split nut in the apron, thus stopping the feed of the carriage. After the trip has once been set it operates automatically, it being merely necessary to reengage the feed by lifting lever *C*. In rough-turning, the average rate of production is four shells

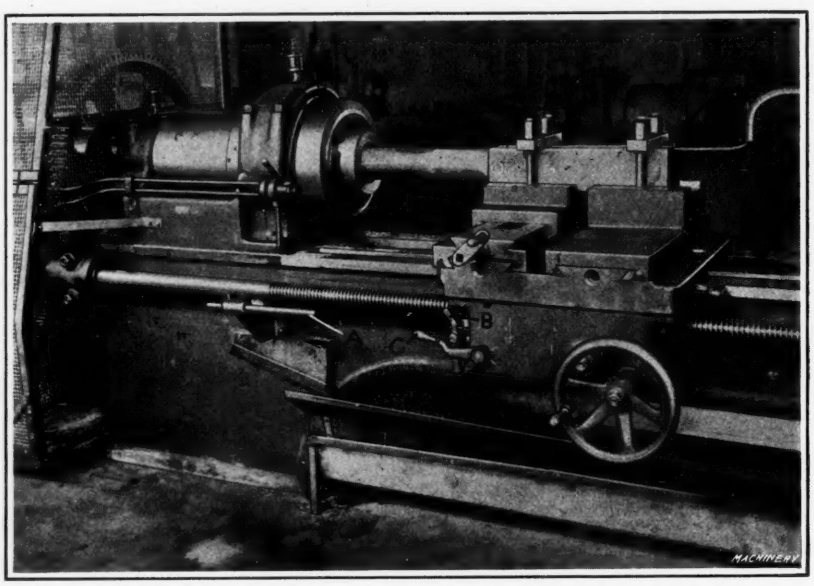


Fig. 5. Machine developed for performing Boring Operation on Shells

per hour; the machine operates at a cutting speed of 45 and 70 feet per minute with a feed of 1/16 inch per revolution. For finish-turning the rate of production is also four shells per hour; the machine operates at a cutting speed of 50 and 75 feet per minute with a feed of 1/16 inch per revolution of the spindle.

Shell Boring Lathe

For performing the rough- and finish-boring operations on the shells, use is made of machines of the type shown in Fig. 5, and reference to this illustration will make it apparent that the description which has already been given of the bed, headstock and spindle of the cutting-off and turning machines, also applies to the boring machines; it will also be evident that the carriage on the boring machines is furnished with the same feed trip mechanism that is used on the turning lathes. The hollow spindle is provided with a three-jaw collet, shown in Fig. 6, which is operated by a Hannifin air chuck. The shells are pushed into this collet and the drilled nose is located over

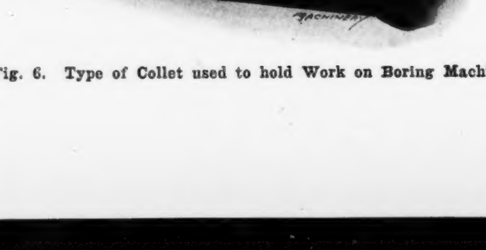


Fig. 6. Type of Collet used to hold Work on Boring Machine

a plug, while the faced end of the nose strikes against a distance stop; then when the air chuck closes, the shell is automatically centered at both ends, ready for the boring operations to be performed.

The advantage gained by removing all eccentricity from the outside of the shell becomes apparent when the work has progressed to the point where the shells are ready to be bored, as having a uniform outside surface enables the shell to be held rigidly and reduces the amount of metal which must be removed during the boring operation. Reference to Figs. 5 and 7 will make it evident that an unusually heavy boring-bar is used, the bar being made from a cast steel section, 4 by 4 inches in size. It will also be noticed that two cross-slides are provided on the carriage to afford a rigid support for the bar; the front slide is guided by a master plate at the back of the lathe which provides for obtaining the required contour for the inside of the shell, and the rear slide simply serves to steady the boring-bar. The cutting tool is mounted at the extreme end of the bar and a stream of cutting compound is directed against the work, the volume being sufficient to wash away all chips.

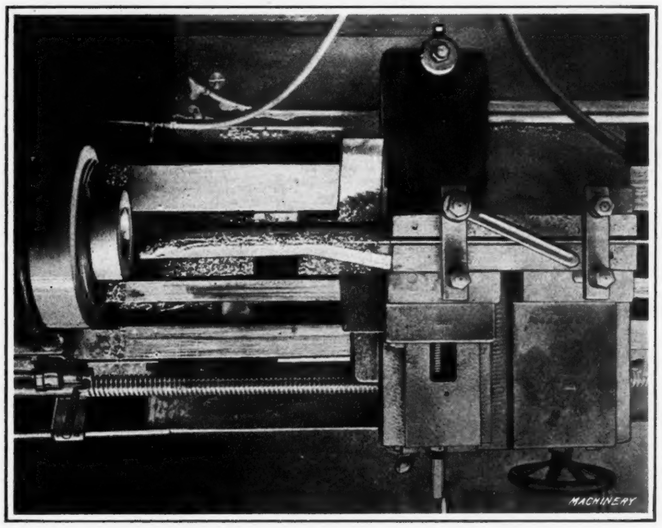


Fig. 7. Close View of Boring-bar set up on Machine

The preceding description applies to the machine used for the rough-boring operation, but a similar type of machine is employed for finish-boring the shells. The two boring operations follow each other and come between the rough- and finish-turning operations on the outside of the shell. This provides for removing the marks made by the serrated jaws of the collet. The average rate of production for rough-boring is four shells per hour and the work is done at a speed of 50 and 75 feet per minute, with a feed of 1/16 inch per revolution. For finish-boring, the rate of production, cutting speed and feed are the same as for rough-boring.

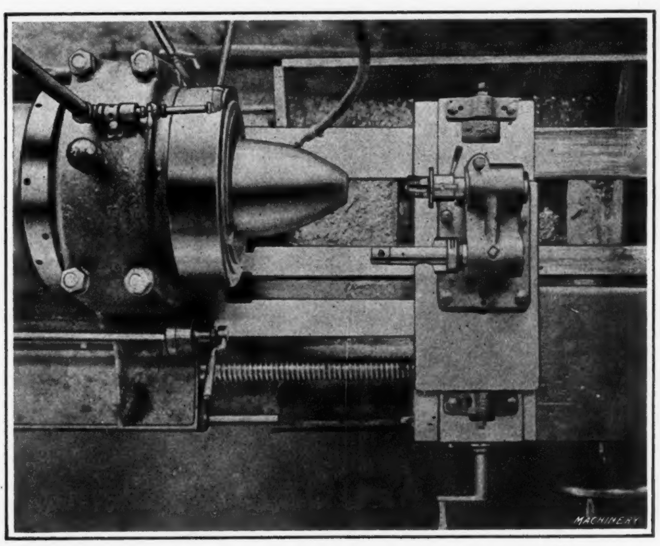


Fig. 8. Close View of Tools on Machine for boring, reaming, facing and tapping Nose of Shell

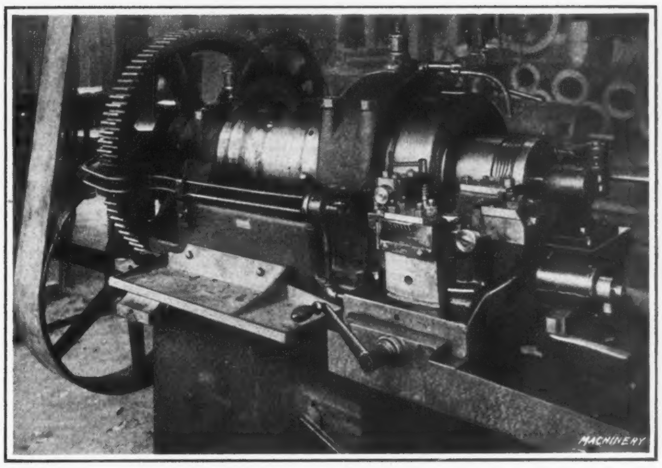


Fig. 9. Machine for turning, under-cutting and waving Band Seat, and facing Shell to Required Length

Nose Finishing Machine

A close view of the tools on the machine developed for use in finishing the nose of the shells is shown in Fig. 8. This machine is of almost exactly the same general design as the cutting-off machine, except that the cantilever bed is about twelve inches longer. The spindle is fitted with the same type of three-jaw collet that is used on the boring machine, as shown in Fig. 6, and provides for holding the shell with the nose out. The carriage carries two tools, mounted on a cross-slide which has two stations. The first tool finish-bores, reams, and faces the nose of the shell, after which the slide is moved over to bring the second tool into the operating position. This is a Murchey collapsible tap used for threading the hole in the nose of the shell to receive the fuse. The average rate of production on this machine is ten shells per hour, the cutting speed is 25 feet per minute, and the feed 1/14 inch per revolution.

Band Seat Turning, Waving and Under-cutting Machine

The Root & Van Dervoort machine for turning, waving and under-cutting the band seat in shells is shown in Fig. 9; it is of the same general design as the nose finishing machine shown in Fig. 8, except that a four-station hand-operated turret

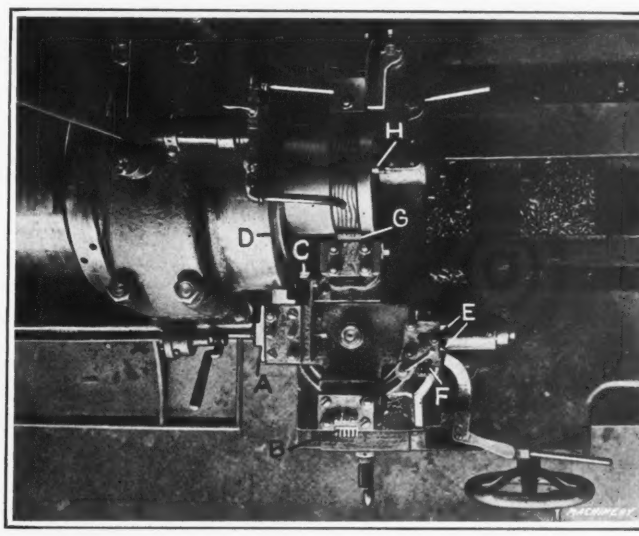


Fig. 10. Close View of Tools used on Machine shown in Fig. 9

is provided in place of a two-station cross-slide. The tools for machining the band seat, which are carried on the turret, are supplemented by a tool on the carriage which is used for cutting off the shell to exactly the required length. There are four sets of tools in the turret for operating on the band groove, and the method of chucking the shell is exactly the same as that used in the rough- and finish-boring operations. A close view of the tool equipment is shown in Fig. 10, and the operations performed on these tools are (1) cutting the band seat, which is done by a cutter *A* of the required width; (2) removing excess metal between waves, which is done by a set of six tools *B*, the form of the waves being ob-

tained by a hardened roller C on the turret which runs in contact with cam D on the face of the spindle; (3) under-cutting, which is done by two tools E mounted on the toolpost and formed to the required angle of the under-cut, the in and out movement of the tools being effected by turning a small worm and worm-wheel F; (4) finishing the waves, which is done by a formed tool G, the movement of which is controlled by a hardened roller which runs against the cam on the face of the spindle. It was mentioned in the foregoing that a tool was provided on the carriage for the purpose of cutting off the shells to exactly the required length. This tool is shown at H in Fig. 10. For the entire sequence of operations performed on this machine, the average rate of production is five shells per hour. The machine operates at a cutting speed of 40 feet per minute and the feed is controlled by hand.

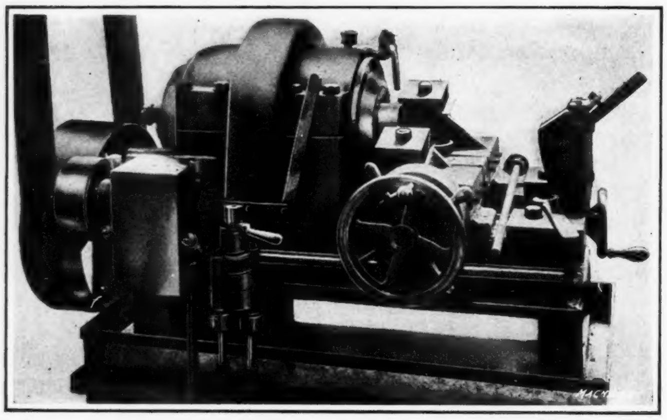


Fig. 1. Machine for cutting off Open End of Shell Forgings

HORNE-DALE-BROWN SHELL MANUFACTURING MACHINERY

The machines described in the following article were originally developed by a well-known firm of machinery builders for use in working on a contract for shells which it has taken from one of the European belligerents. But the results obtained with the machines have been so satisfactory that it has been decided to place them on the market. The design of each machine is quite simple, so that an unskilled operator can soon be taught to run it, and all of the machines are rigidly constructed to stand up under the severe service which is usually met with in munition factories.

This article describes a line of single-purpose shell manufacturing machines which have been designed to withstand the wear and tear of continuous service in munition factories. As a large part of the machining operations on shells are likely to be performed by unskilled labor, these machines have been made as simple and as nearly fool-proof as possible. They are manufactured by a well-known firm of machinery builders which is working on a large contract for shells; and this concern decided to build special machines for its work, because of the difficulty of securing early deliveries from manufacturers of machine tools. The experience of this firm in building machinery, combined with the study which its engineers have made of the problems connected with shell manufacture, has resulted in the development of machines which are particularly well suited to the requirements of the work for which they are intended.

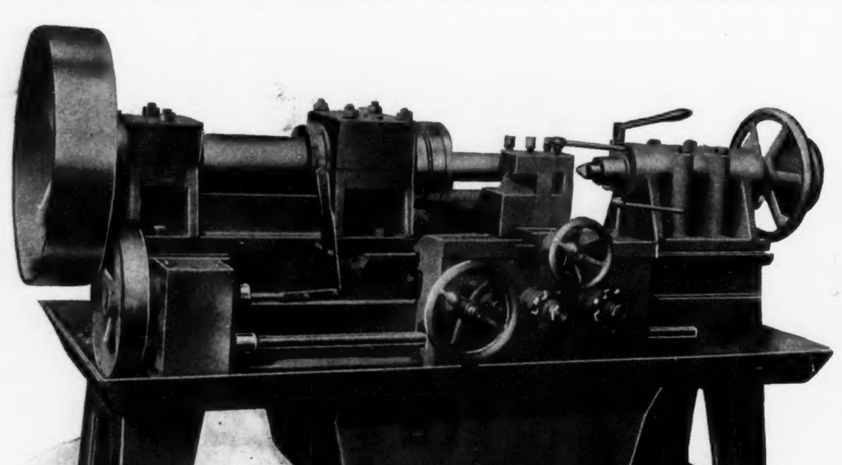


Fig. 2. Machine for rough-turning Outside of Shells

The Horne, Dale, Brown Co., Inc., 545 W. Washington Boulevard, Chicago, Ill., has the sales agency for this line of shell machinery, which includes tools for (1) cutting off shell forgings to length; (2) rough-turning and facing; (3) machining, waving and under-cutting band seat; (4) boring and reaming powder pocket; (5) boring, facing and threading nose of shell; (6) finish-turning body and nose of shell; (7) pressing on copper band; (8) turning copper band; and (9) marking shell. The machines are made in different sizes and have capacities for handling shrapnel and high-explosive shells up to 6 inches in diameter. The average rate of production for each machine is given in the accompanying table, these production figures being taken from the time sheets of a plant which has been using the machines continuously over a period of three months.

Fig. 1 shows the machine used for cutting off the end of the shell forgings to reduce them to standard lengths; the machines developed for machining the band groove, facing the end of the shell to reduce it to standard weight, machining the nose of the shell, and finish-forming the outside of the nose are also of the same general design. In other words, the designs of all the machines in which the work is held in the chuck are the same. It must be understood, however, that the designs of the carriage and cross-slide on the different machines are varied to meet the requirements of the particular operations for which each is intended. It will be evident from Fig. 1 that these machines are of compact design and massive construction, and that all parts are built without overhang so that chatter and vibration are practically eliminated. The entire operating mechanism is governed by a centralized control, and is so simple that an unskilled workman may soon be taught to operate the machine.

PRODUCTION ON 3.3-INCH BRITISH SHRAPNEL SHELLS

Operation	Machine	Average Time, Minutes
Cutting off end	Cutting-off machine	1.3
First rough-turn face	Roughing lathe	6.0
Second rough-turn, finish-face end and finish-turn from base end up to end of band groove	Roughing lathe	10.0
Groove, wave and under-cut	Grooving machine	3.0
Bore and ream	Drill press	3.0
Bore, face and tap nose	Nose end lathe	3.0
Finish-turn body and nose	Finish-turning lathe	4.0
Press copper band on shell	Banding machine	0.5
Turn copper band	Copper band turning machine	0.4
Stamp	Stamp rolls	0.1

Machinery

Fig. 3 shows the type of spindle construction which is employed, and reference to this illustration will show that the spindle, chuck and air control—with the exception of the piping—are of unit construction. The spindle is made of steel, and by having the driving gear located at a point mid-

way between the bearings, the strain is equalized as far as possible. The bearings are $9\frac{1}{2}$ inches in diameter by 6 inches long and are lined with babbitt. The chuck is of the double-acting type, and is instantaneous and positive in operation. All parts subjected to exceptionally severe service are made of tool steel and hardened. The machine is driven by a pinion which is located beneath the driving gear, and the driving shaft runs in bronze bushed bearings. All working parts are carefully protected from chips and dirt, but the guards are designed in such a way that the mechanism is accessible for oiling; all parts which are subjected to wear are provided with means of making adjustment.

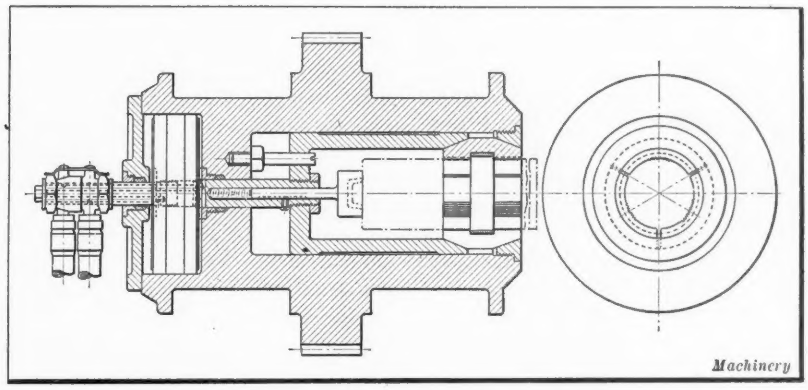


Fig. 3. Spindle of Cutting-off Machine and other Machines of this Type

The cutting-off machine is equipped with two cross-slides actuated by means of a right- and left-hand screw, which may be operated by hand or driven by power, three rates of power feed being available. The toolpost on each of these slides is cast integral with the slide, and is designed to give exactly the proper angle to the tool. The clamps are made of hardened tool steel with a spring release. The position of the carriage on the bed is adjusted by means of the handwheel at the end of the bed. A fixture is shown at the end of the machine which is used for quickly setting the shell to the proper distance in the chuck. It will be seen that the machine is furnished with a lubricant pump which is of the geared type and is located beneath the cast-iron pan that forms an integral part of the feet and legs of the machine. The time required for cutting off the 3.3-inch shells is 1.3 minute.

Roughing Lathe

For performing the rough-turning operations on the shells, the type of machine shown in Fig. 2 is employed. It will be evident that this lathe is rigidly constructed to meet the severe service for which it is intended. The spindle is 6 inches in diameter in the front bearing and 4 inches in diameter in the rear bearing; and it has a hole $1\frac{1}{2}$ inch in diameter bored through it. The tailstock is provided with two screws for adjusting the center; one of these has a coarse thread for fast movement and the other a fine thread for tightening. Three traverse and three coarse feeds are provided, and provision has been made for hand feed in both directions. All gears in the apron are made of steel with the exception of the worm-gear which is made of bronze.

The turning is done in three operations and the machines for taking the roughing, intermediate and finishing cuts are practically the same. The chief difference lies in the fact that the lathes for roughing are provided with one gear reduction on the spindle, while the lathe for performing the second roughing operation is driven direct by means of a pulley on the spindle. The floor space occupied by these machines is 7 feet by 3 feet, 6 inches. In turning 3.3-inch British shells, the roughing cut requires six minutes and the intermediate cut ten minutes, while the finishing cut is done in four minutes. In this connection it may be mentioned that the finishing cut is taken after the various operations have been performed on the band groove, powder pocket and nose end of the shell.

Machine for Boring and Reaming Powder Pocket

For use in boring and reaming the powder pocket a single-spindle drill press has been developed which is illustrated in Fig. 6. In working out the design of this machine particular attention has been paid to the development of a rigid construction which would be capable of preserving the alignment of the spindle and table under exceptionally severe conditions of service. It will be seen that the machine is built with a one-piece column and base casting; and the spindle is made of chrome-vanadium steel, carefully heat-treated to take full advantage of the physical properties of the metal. The spindle bearings are lined with phosphor-bronze, and the spindle is driven by a single pulley 31 inches in diameter, which carries a 6-inch double belt, so that ample bearing is provided. Both

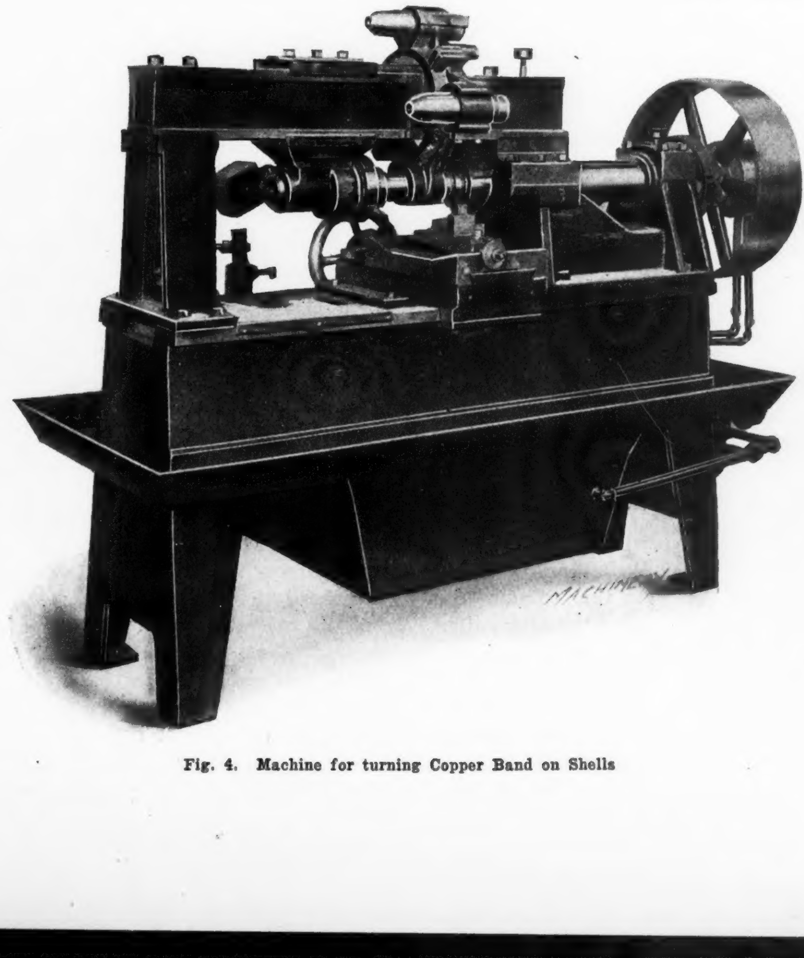


Fig. 4. Machine for turning Copper Band on Shells

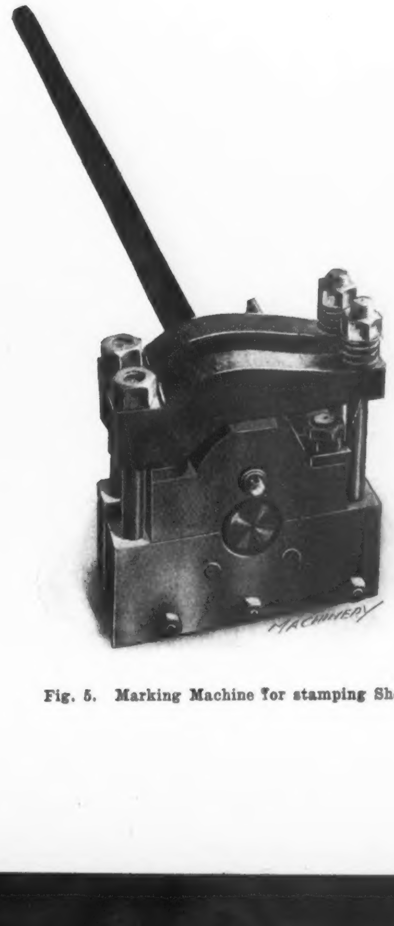


Fig. 5. Marking Machine for stamping Shells

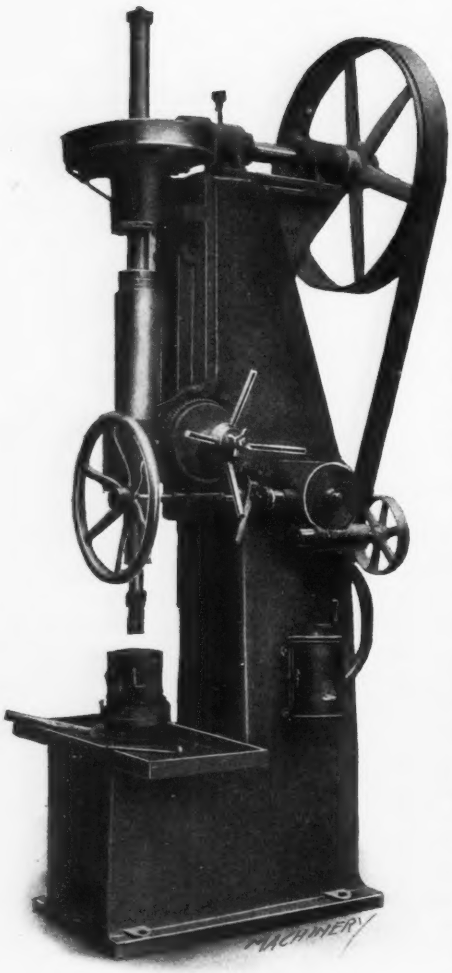


Fig. 6. Vertical Drill Press designed for boring and reaming Powder Pocket

hand and power feed are furnished, the power feed being of the friction type so that it may be quickly engaged and released; hand feed is controlled by a wheel 24 inches in diameter. Automatic trips provide for releasing the power feed. On 3.3-inch British shells the boring and reaming of the powder pocket can be completed in three minutes.

Finishing the Nose

It will be recalled that in referring to the general characteristics of the Horne-Dale-Brown shell machinery, the statement was made that the machine for boring, facing and tapping the nose of shells was of the same general design as the cutting-off machine illustrated in Fig. 1. This will be readily understood by comparing Figs. 1 and 7, which show these two machines. Reference to the latter illustration will reveal the fact that a vertical turret is provided on the cross-slide; this turret has three stations and the turret tools divide the work as follows: (1) bore hole and face end of nose; (2) form inside radius; and (3) tap hole. The turret has been designed in such a way that it operates rapidly and is sufficiently rigid to maintain accurate alignment. The machine is equipped with both hand and power feed, the former being operated by large handwheels, while any of three rates of power feed are available. A geared pump furnishes lubricant for the tools; it is located beneath the cast-iron pan on the machine. The average time required for machining the nose of British 3.3-inch shells is three minutes.

Copper Band Turning Machine

For turning the copper rifling band on the shells, the machine shown in Fig. 4 has been developed. This is of the continuous turning type; the operator loads and unloads the machine while the copper band is being turned. The formed turning tool is held in a vertical position on the carriage, and it can be quickly taken out for grinding; special means are provided for rapidly resetting the tool after it has been sharpened. During the operation of turning the copper band and loading the machine, it is unnecessary for the operator to leave his position at the front of the carriage. The magazine which has a capacity for four shells, is rotated in a vertical position and stops automatically when the shell is in alignment with the chuck and centering device. With his right hand the operator raises the lever on the centering device, and this pushes the shell into the chuck; then with his right hand, he operates an air valve and the shell is chucked ready for turning the band groove. A single turn of the handwheel on the carriage then brings the turning tool into the working position, after which the cross-feed is thrown in.

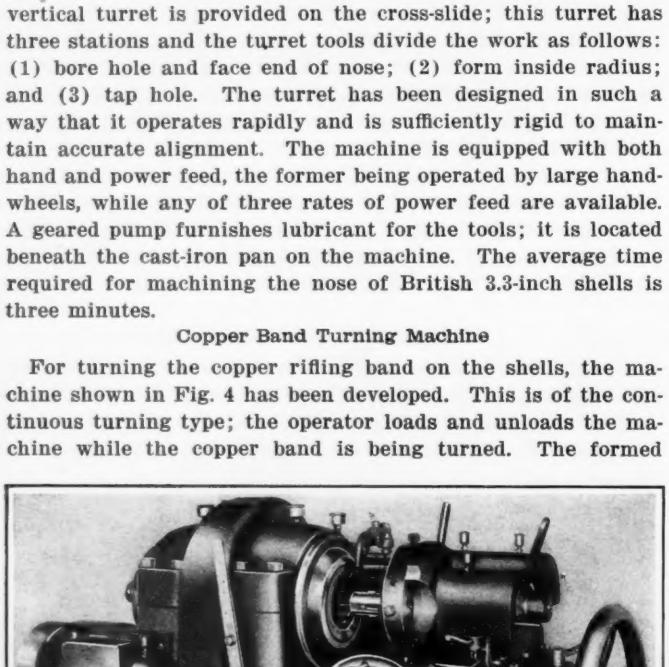


Fig. 7. Machine for boring, facing and tapping Nose of Shell

While the band is being turned on this shell, the operator removes the finished shell and places an unturned shell in the magazine. When the copper band has been turned on the shell held in the chuck, the feed is thrown out by an automatic trip, after which the tool is run back by hand, the chuck opened, and the centering device pushed back; the magazine is then rotated to bring another shell into the operating position. The chuck jaws are made of hardened steel and the end of the shell engages a centering device which assists in locating it properly in the chuck. This cycle of operations has been performed five times a minute when making a test run on 3.3-inch shells, but the average rate of production is 0.4 minute per shell.

Marking Machine

For marking the shells, the equipment shown in Fig. 5 has been developed. The bed of this tool consists of two parts, *i. e.*, a base and top which are joined at the center line of the shell and held together by four bolts. Two of these bolts are furnished with springs adjusted to the proper tension to raise the top when the bolts are released. The main shaft of the machine carries a stamping roller and operating lever, and two lower shafts carry rollers upon which the shell rests. The shafts, bearings and rollers are made of tool steel, hardened and ground. The machine operates rapidly; the operator puts in a shell with one hand, and with the other he pulls down the lever which rotates the marking roller that stamps all required notations on the wall of the shell. On this operation, the average rate of production for 3.3-inch shells is 0.1 minute.

BRYANT RADIATOR NIPPLE TURNING MACHINE

O. Bryant, Sons & Co., Buffalo, N. Y., specialists in radiator manufacturing machinery, have recently perfected the machine shown in the accompanying illustrations for the automatic turning of radiator nipples. These nipples are made of malleable iron castings, varying from 1¾ inch to 2¼ inches diameter, and from 1¼ to 1½ inch in length. They are cored out so that the walls are about 3/16 inch thick. Fig. 1 shows the approximate proportions of one of these nipples, and the turning operation consists of machining the cylindrical outside surface, which is usually slightly convex or "crowned" like a pulley. The amount of metal removed is from 1/16 to 3/32 inch on the diameter. The nipple castings are fed into a chute and are automatically chucked, turned and ejected at the rate of from 1200 to 1800 a day, the output of the machine varying with the size of the nipples and the quality of the iron. Figs. 2 and 3 show the front and rear views of the machine, and Fig. 4 shows a partial end view.

The spindle that carries the nipple to be turned runs lengthwise of the machine in the two bearings that may be seen in Figs. 2 and 3, and the entire drive of the machine is received on this spindle from an overhead countershaft belted to the large spindle pulley. From the extreme end of this spindle, rotation is carried to the worm-shaft below, and from this worm-shaft power is taken for performing the entire cycle of operations. Referring now to Fig. 3, it will be seen that on the worm-shaft there is a clutch to start or stop rotation. Midway of the length of this shaft is a pulley that drives a lubricant pump beneath it. On the extreme left end of this shaft

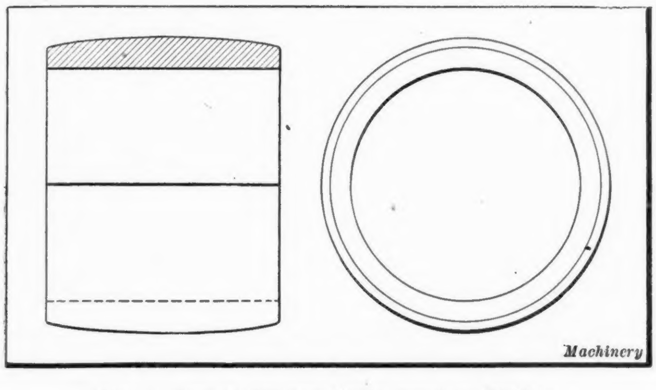


Fig. 1. Type of Radiator Nipple turned on Machine

is the worm that meshes with a worm-wheel mounted on a shaft at right angles to the front shaft. From the latter shaft the carriage traversing and chucking mechanisms are operated.

The turning slide is located on the wide bracket that may be seen bolted to the column of the machine at the center in Fig. 3. On the shaft that is driven by the worm-wheel, there is a cam that acts on one end of the bell-crank that may be seen just above it. The upper end of this bell-crank carries a link that is attached to the tool-slide. A spiral spring, that may also be seen in this view, serves to keep the slide as far to the left as possible when it is not being operated by the cam. Thus, under the action of the cam, the slide is carried to the right; and by means of the spring, it is withdrawn.

From this point the operation of the machine can best be followed by referring to Fig. 4. The nipples run down a chute from the front, and they are prevented from dropping into the working position by the feed slide shown in Fig. 2 directly at the center of the upper part of the machine. This slide is kept normally forward, intercepting the string of nipples except when it is withdrawn to permit a new nipple casting to be fed. This slide is actuated by a lever at the front of the machine, and its action is secured from a segment cam that may be seen on the worm-wheel shaft in Fig. 2. The tool is clamped in a tool-block at the top of which there is a roll bearing against a former plate. A concealed spiral spring keeps the block up against the former plate, and this plate is shaped to give any degree of crowning desired.

It is necessary, at the end of the turning operation, to provide means for removing the tail-center from the work, and allowing the nipple to drop out. This is done by the square column that may be seen extending above the frame of the machine in Figs. 2 and 3. The column carries a cylindrical weight at the top and is raised by a cam on the worm-wheel shaft. The column is slotted to receive a stud passing at right angles through the tail-center, and as this slot is inclined, the raising of the column causes the stud, and hence the center, to be withdrawn. When it is dropped, the center is advanced quickly into the nipple, holding it firmly for the turning operation. The weight on the square column that operates the tail-center helps to "seat" the work quickly on the centers. Both centers are cone shaped; the live center is toothed for driving and the tail-center is mounted on ball bearings.

When the nipple drops from the centers, it falls into a chute and runs out at the left-hand side of the machine, as viewed from Fig. 2. This chute is perforated so that the chips turned from the nipple drop through into a drawer that may be seen through the rectangular opening at the sides of the machine.

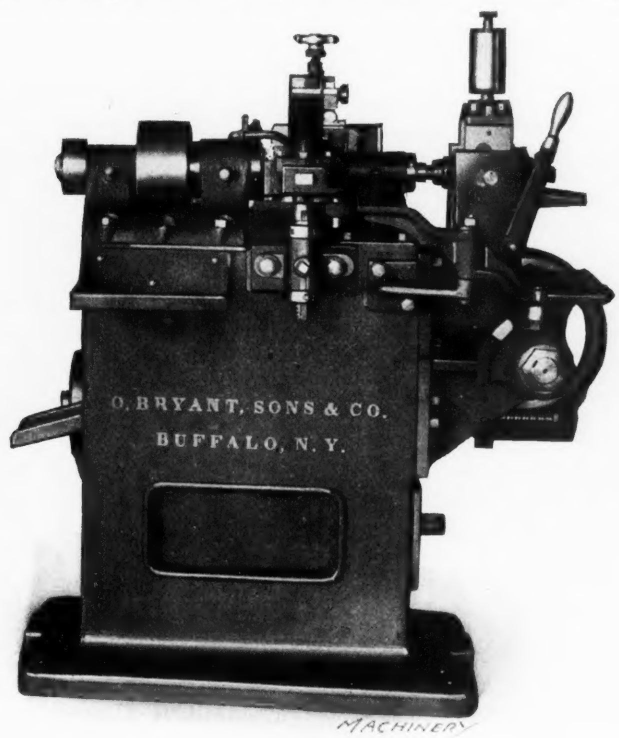


Fig. 2. Front View of Bryant Radiator Nipple Turning Machine

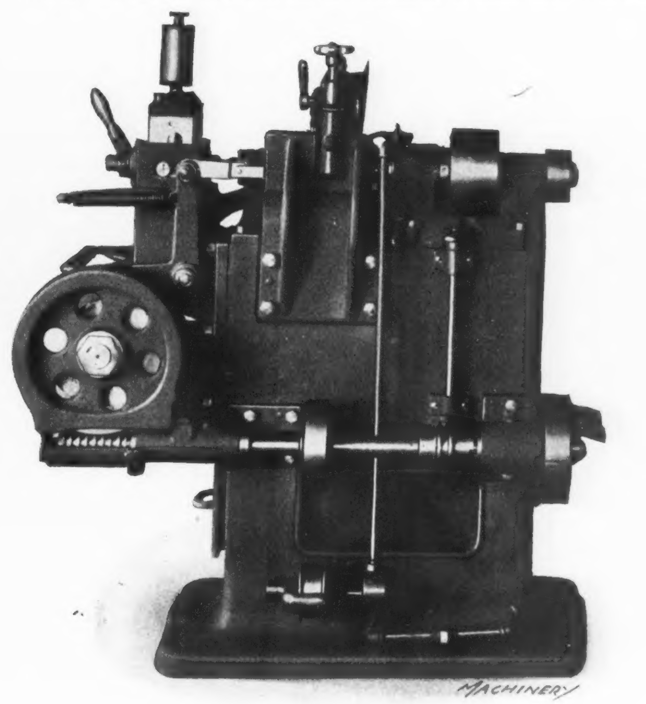


Fig. 3. Opposite Side of Machine shown in Fig. 2

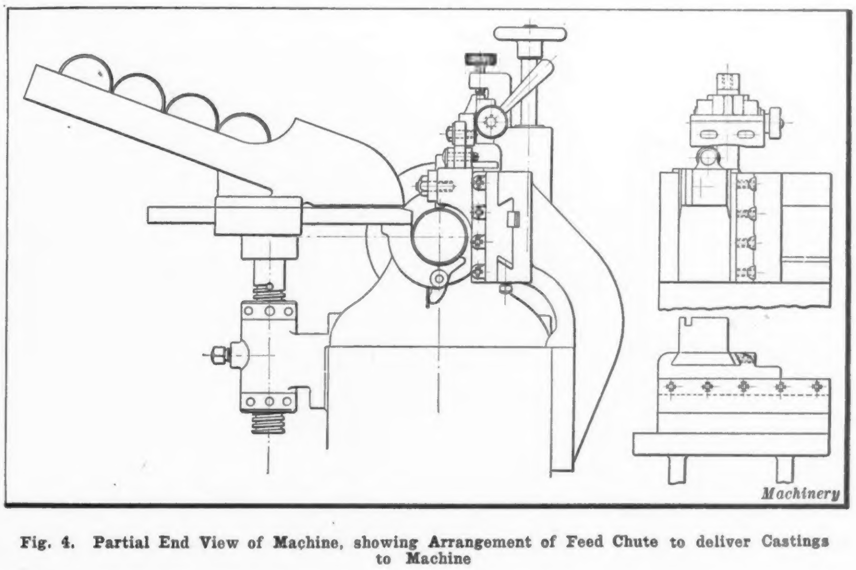


Fig. 4. Partial End View of Machine, showing Arrangement of Feed Chute to deliver Castings to Machine

This drawer may be removed and emptied of chips from time to time, thus promoting the maintenance of a cleanly condition and neat appearance with a minimum of care and attention.

This machine is entirely automatic in operation except for the filling of the feed chute with the nipple castings. The rate of production is very high, varying, of course, with the size and character of the nipples which are being turned, but the average is from 1200 to 1800 nipples per day.

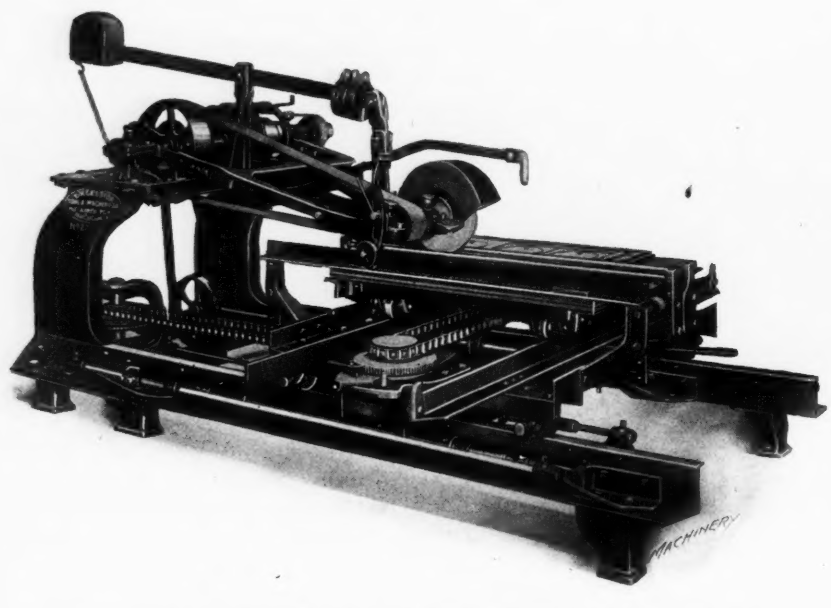


Fig. 1. Excelsior Automatic Grinding and Polishing Machine working on Stove Tops

EXCELSIOR GRINDING AND POLISHING MACHINE

For use in grinding, surfacing and polishing flat or convex castings or metal plates, or for performing these operations on pipe, the Excelsior Tool & Machine Co., E. St. Louis, Ill., has recently placed on the market the machine shown in the accompanying illustrations. While it can be used for finishing a variety of products, it is especially adapted for the work of stove manufacturers. Fig. 1 shows the machine engaged in grinding stove tops, and for this purpose use is made of both the upper and lower carriages which provide longitudinal and transverse feed to pass the work under the wheel. Fig. 2 shows the machine equipped with a pipe polishing attachment. Fig. 3 shows an end view of the machine, which illustrates the way in which the feed mechanism and the exhaust fan are connected to the driving shaft.

In working out the design of the machine, attention has been paid to the combination of efficiency and flexibility, and while all parts of the mechanism have been constructed to withstand severe service and to prevent damage from abrasive dust, these results have been obtained without reducing the efficiency of the automatic features in any way. The starting and stopping of the carriages, shifting them to any desired location, altering the speed, stroke or feed, regulating the pressure of the wheel on the work, lifting the wheel off the work or adjusting it to any desired height, are changes that can be instantly made while the machine is in motion.

Each movable part is so constructed that when the machine is started and the feeds engaged, they will be automatically released at the end of the travel, which avoids damage from carelessness on the part of the operator. The main swing frame is supported on roller bearings which allow a free and easy movement over the work. Adjustments for regulating the belt tension are provided, and the pressure of the grinding wheel on the work—which should be about 25 pounds—is regulated by a slotted weight mounted on a balancing bar. The grinding wheel on the machine should be carefully balanced in order that it may run true without a tendency to set up vibration; the size of the wheel is 12 inches in diameter by 2 inches face width, and it is 60 grain, O grade. It will be seen that a dust hood is provided to carry away all dirt and dust. Means are provided for accurately setting the wheel so that it will not drop below a specified minimum level, and when the machine has been properly adjusted in this way the wheel may be lifted off the work and locked without stopping the machine.

An adjustable slotted roller casting on the left-hand end of the spindle is used to raise the grinding wheel off the work at the end of each stroke by rolling on suitable wedges which are adjusted for the travel of the lower carriage. The travel of the lower truck can be adjusted anywhere from 12 to 60 inches by setting the reverse stops on the right-hand rod under the truck; the rod on the left-hand side has similar stops which provide for regulating the feed of the upper truck. These stops should always be released and adjusted last; otherwise the pins on the ratchet will interfere. These pins are made to bend before sufficient strain is applied to break the ratchet casting. Beneath the ratchet feed there is a "bumper" mechanism which engages the spring stops on both sides; this "bumper" must always be released and set after the proper travel of the carriage has been established, after which the stops may be set.

Fig. 2 shows the machine equipped with a pipe polishing attachment which is constructed in such a way that it may be put in place or removed from the machine in twenty minutes. It consists of an angle iron support to which are clamped the headstock and tailstock. The machine is adapted for working on ½, ¾ or 1 inch pipe in lengths from 6 inches to 60 inches. Two rest brackets hold the pipe in line with the centers and assist in quickly inserting or removing the pipe; and two clamp brackets are set to release the feed at each end of the work. After the attachment has been set for working on pipe of a specified length and the feed has been started in either direction, the feed is stopped and the wheel raised automatically.

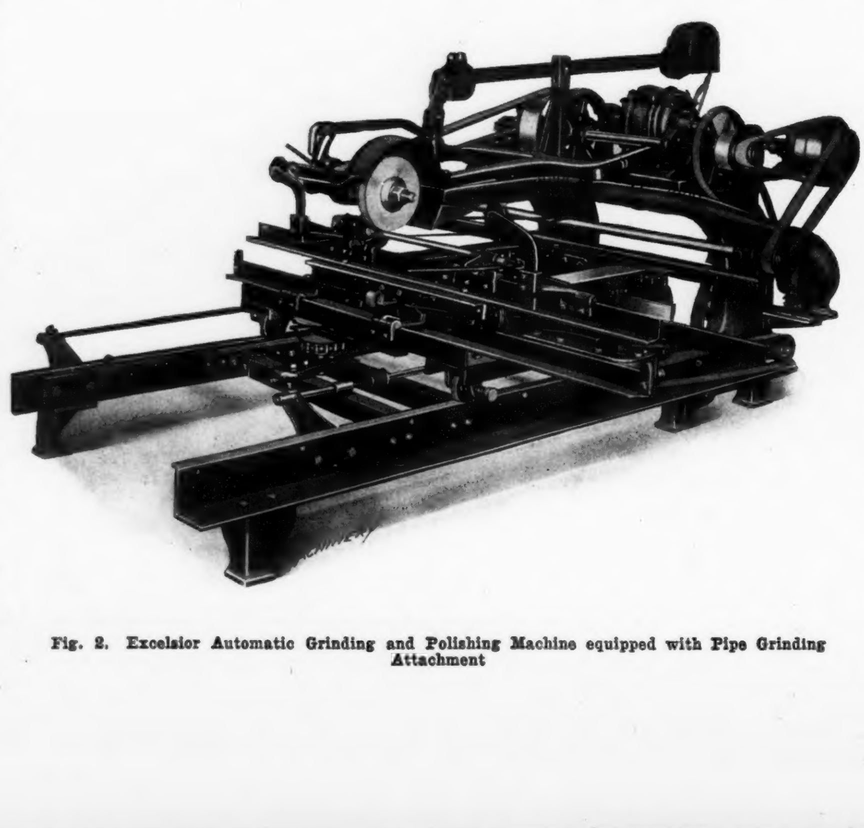


Fig. 2. Excelsior Automatic Grinding and Polishing Machine equipped with Pipe Grinding Attachment

The upper carriage is operated by the set of worm-gears belted to the lower shaft, and to hold the lower carriage in the proper position a lock bracket is fastened to a large angle iron that clamps the lower carriage wheel. The engaging shifter in front, which operates the lower carriage, should always be locked when polishing pipe. In grinding pipe, the work revolves at 350 revolutions per minute in a direction opposite to that in which the grinding wheel runs; the feed across the pipe is at the rate of 9½ inches per minute. The travel of the lower truck is 58 feet per minute. These speeds may be cut in half by shifting the driving belt on the cone pulley. The cross-feed of the upper truck is changeable, rates of ¼, ½, ¾ and 1 inch feed for each stroke of the truck being available. The quantity of work produced on the machine naturally depends on the area and shape of the castings, the smoothness of finish required, and the type of grinding wheel with which the machine is equipped.

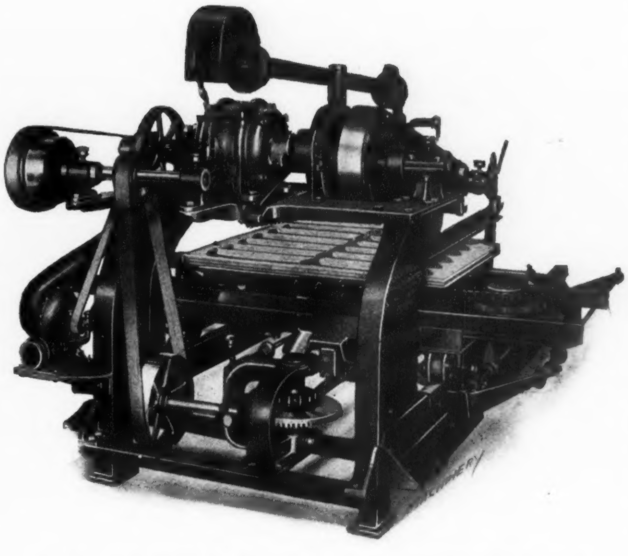


Fig. 3. End View of Machine showing Arrangement of Drive to Feed Mechanism and Exhaust Fan

MANNING, MAXWELL & MOORE MACHINERY FOR RIFLE MANUFACTURE

To meet the requirements of factories engaged in the manufacture of military rifles, Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, is now marketing a line of machines, the designs of which have been carefully worked out to make them suitable for performing machining operations on various rifle parts. Machines of this type are in use in the Eddystone plant of the Remington Arms Co., which is probably one of the most efficiently equipped rifle factories in the world, as the engineers who directed the selection and installation of the equipment were able to benefit by experience gained in organizing other factories for producing the same product. The machines are being manufactured by the Reed-Prentice Co., Worcester, Mass.

Single-tool Rifle Barrel Turning Machine

The machine used for turning rifle barrel forgings is of the form shown in Fig. 1. It will be evident from this illustration that its general features are those of a lathe, so that the present description may properly be confined to the means provided for automatically turning the barrel to the required shape. This is accomplished by having a master plate at the back of the lathe, which moves the cross-slide in and out so that the tool always takes a cut of just the required depth to provide for turning the barrel to the required form. As the barrel forgings are more than 30 inches long and quite slender, it will be evident that the use of a steadyrest is necessary to prevent deflection, and that the transverse position of this steadyrest must also be controlled from the master plate at the back of the lathe. The machine is capable of finish-turning a rifle barrel in twenty minutes.

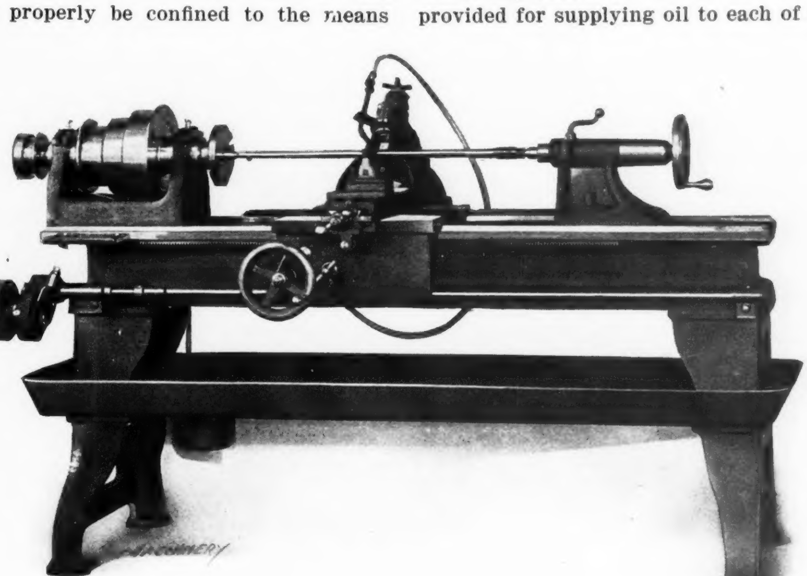


Fig. 1. Single-tool Rifle Barrel Turning Machine

Multiple-tool Rifle Barrel Turning Machine

In the manufacture of military supplies of all kinds, the necessity for employing labor saving devices and means for turning out the work as rapidly as possible is even more important than in general lines of manufacture, because of the time clauses which exist in most contracts, and on account of the scarcity of labor which has been created by an abnormal demand. With the view of cutting down the time required to turn rifle barrel forgings, it was decided to produce an automatic lathe equipped with a multiple system of tool-blocks. Reference to Fig. 2 will make it evident that this machine has five tool-blocks, and as a result, it is only necessary for each tool to travel a distance slightly in excess of six inches to complete the operation of turning a 30-inch rifle barrel. As in the case of the single-tool machine, the form of the work is controlled by a master cam which governs the transverse movement of the tool-slides, but the use of this multiple-tool system reduces the time of turning a barrel from twenty minutes to approximately two and one-half minutes. On the Lee-Enfield-Remington rifle barrel, after the bore has been drilled and countersunk, it is put in a grinding machine and spotted in the center to form a bearing for the roll on the steadyrest used on the lathe shown in Fig. 2. For rough-turning, the work is rotated at 335 R. P. M., with a feed of 0.026 inch per revolution and a cut of ⅛ inch on the diameter. The actual time required to turn one barrel is two and one-half minutes, which includes putting in the work and setting the machine.

In a general way, the design of the machine follows standard practice in lathe construction, but the carriage supporting the tools is fitted with an automatic trip, and when the tools have been fed to a point where the turning operation is completed, this trip automatically releases the carriage so that a counterweight may return it to the starting position, and the automatic feed is stopped. The machine has a pump for delivering lubricant to the work, five delivery tubes being provided for supplying oil to each of the tools. As in the case of the single-tool machine, provision is made for supporting the work with backrests, and it will be seen that two backrests are provided, although one is ample, except in the case of very long barrels.

External Thread Milling Machine

For threading the breech end of a rifle barrel to screw into the receiver, an external thread milling machine has been developed which is illustrated in Fig. 3. This illustration shows the different

parts of the mechanism so clearly that a brief description will suffice to give the reader a clear understanding of the machine. It will be seen that in general the design follows that of a lathe, the machine being provided with a geared head and lead-screw for traversing the carriage along the bed. Supported on the carriage there is a single thread milling cutter, and the work is held in a collet in the spindle so that it may be rotated at the required speed. A swing stop is provided for locating the barrel in

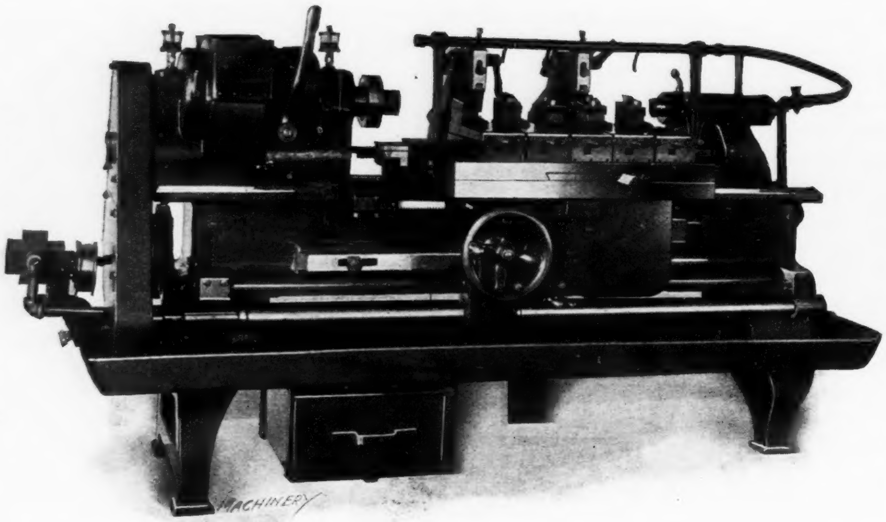


Fig. 2. Multiple-tool Rifle Barrel Turning Machine

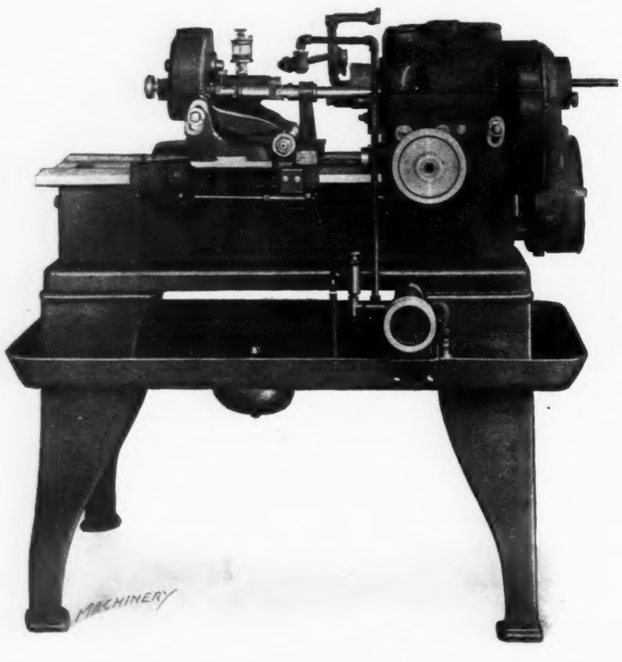


Fig. 3. External Thread Milling Machine for threading Rifle Barrels

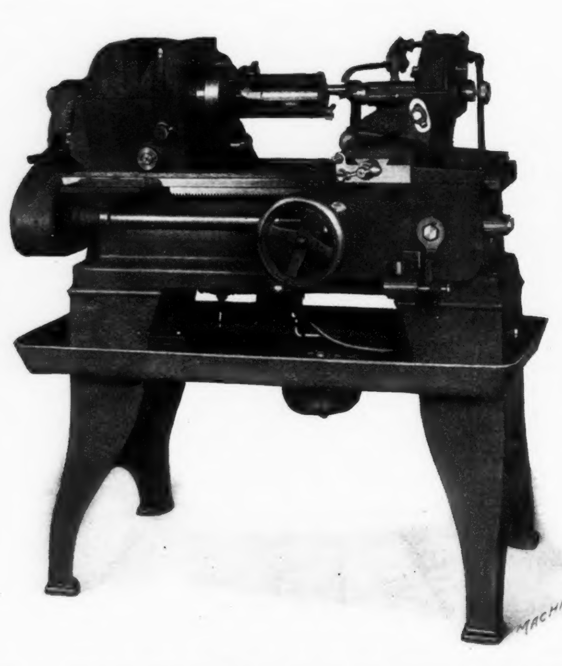


Fig. 4. Internal Thread Milling Machine for threading Rifle Receivers

the correct position in the collet. The rate of production is eight to ten barrels per hour. It will of course be evident that by gearing the machine to obtain the proper relation between the speed of rotation and rate at which the carriage is traversed along the bed, a thread of the desired lead will be obtained; also, provision is made for setting the cutter-spindle at any required angle to mill the thread.

Internal Thread Milling Machine

The machine shown in Fig. 4 is of essentially the same design as the external thread milling machine shown in Fig. 3, but this machine is used for milling the internal thread in rifle receivers to provide for screwing the barrel into place. Except for the fact that the spindle is furnished with a suitable fixture for holding the receiver — instead of having the breech end of the barrel extend through the spindle—the design is the same as that of the external threading machine. In this machine the work is rotated at 3¼ R. P. M., and the cutter runs at 800 R. P. M. The rate of production on this operation is sixteen to twenty per hour.

Barrel Chambering Machine

Hand screw machines have been commonly used for chambering rifle barrels, and in many ways they were capable of giving very satisfactory results; but for doing this work a set of eight turret tools is required and the ordinary hand screw machine is fitted with a turret containing only six holes. Of course it would be an easy matter to substitute a suitable turret, but in building a machine for chambering large numbers of rifle barrels, other

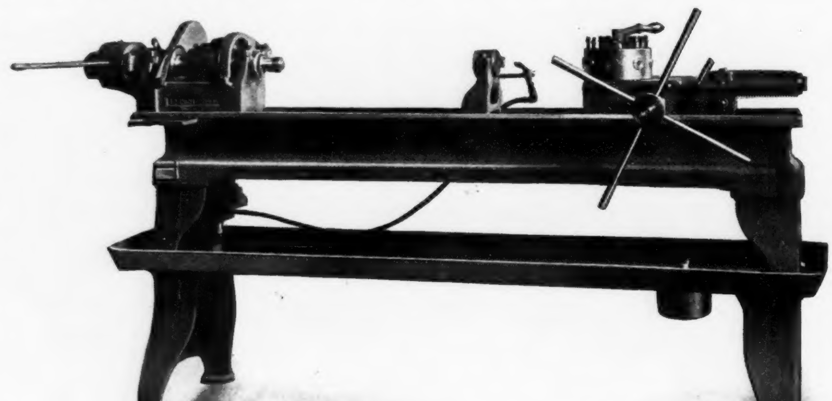


Fig. 5. Machine designed for Use in machining Chamber in Rifle Barrels

modifications of design suggested themselves, and the machine shown in Fig. 5 represents the result of an effort to construct a special tool for doing this work. It will be evident from the illustration that the muzzle end of the barrel is secured in a collet in the spindle, which is operated by the long hand-lever at the extreme left of the machine. The breech end of the barrel is supported in a bushing in the steadyrest and the turret provides for holding eight tools. The arrangement of the pump and piping for delivering cutting compound to the tool is clearly illustrated.

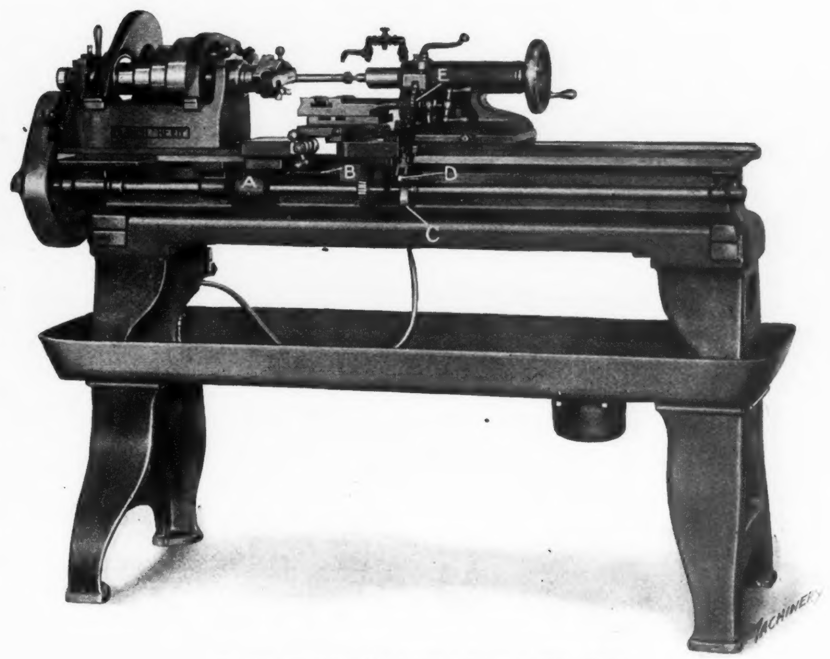


Fig. 6. Machine for turning Cam on Rifle Bolts

Light Automatic Lathe for Bolt Turning and Squaring

After the rifle bolt has been centered it is sent to the automatic lathe for turning the body and squaring down the inside of the lever portion. This work is performed by the use of a special tooling arrangement whereby two tools are simultaneously used on the body, while a single tool supported in a back arm tool-holder is operating on the side of the lever. This machine is of the automatic type, the only attention it requires from the operator being that of replacing the work between centers and engaging the feed. The machine then does the turning and facing, automatically disengages the feed, and withdraws the tools from the work to prevent scoring while the carriage automatically returns to its starting position. The compact design has made the machine very rigid, which is essential to successful operation on this class of work.

Cam Facing Lathe

The work of facing the cams on rifle bolts can be advantageously done on the machine shown in Fig. 6, which has been developed for this purpose. A special mechanism is used for controlling the movement of the cutter that produces the locking-cams on the bolts, and a special feeding mechanism moves the cutter through the required distance per revolution of the work. As shown in Fig. 6, the cross-slide which carries the cam facing tool is operated by means of a cam *A* held on the rod passing along the front of the machine. This cam has two projections corresponding with the two lugs on the bolt, and the cross-slide is kept in contact with it by heavy springs, one of which is shown at *B*. The facing of the cams is accomplished by a wide parting tool held in the toolpost of the lathe and operated by a cam also held on the lead-screw. This cam is shown at *C* and runs in contact with a roller *D* that operates a series of fulcrum levers which, in turn, act upon a ratchet feeding finger that rotates the ratchet dial *E*. This dial is connected to the tool-slide screw and moves the tool in against the work at the rate of about 0.0005 inch per cut, that is, the tool-slide is moved over 0.001 inch per revolution of the work. As there are two cam surfaces to cut, the cut on each cam surface would be, of course, half that amount. The work is rotated at 30 R. P. M. and the rate of production is from twenty to twenty-five per hour.

Semi-automatic Lincoln Type Miller

A number of the parts of military rifles are finished by milling, and for performing this work, the semi-automatic Lincoln type miller shown in Figs. 7 and 8 is now being built. The design of this machine is practically standard, with the exception of the table mechanism by means of which the work is fed under the cutter, after which the table is dropped sufficiently so that the work clears the cutter as the table is automatically returned to the starting point. After the table is returned, it again rises to the operating position and then stops until the

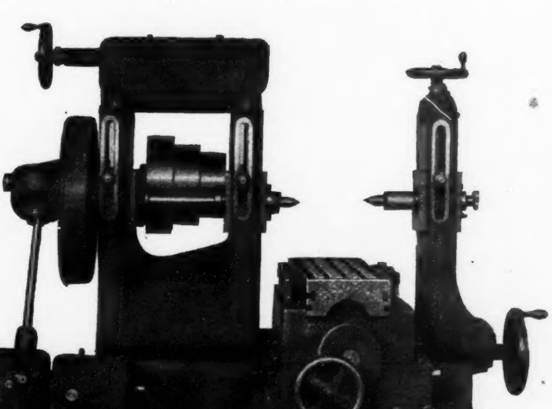


Fig. 7. Lincoln Miller with Automatic Feed and Table Return

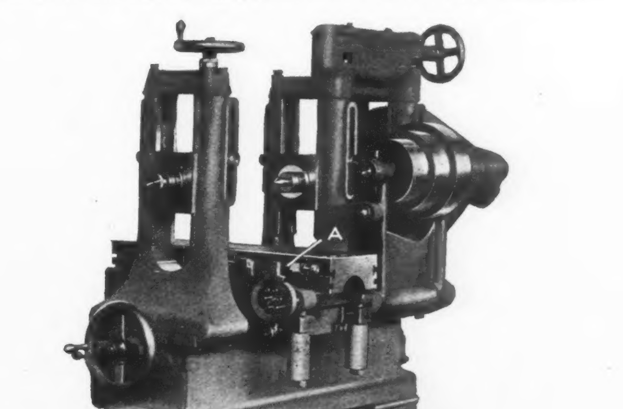


Fig. 8. Opposite Side of Lincoln Miller shown in Fig. 7

operator, who is in charge of a battery of machines, has removed the finished piece, substituted a fresh blank, and thrown in the feed trip to reengage the feed gears. Lubrication is taken care of by means of a pump and piping.

The best understanding of the way in which the machine operates will be gained by referring to Fig. 8, which shows the rear view of the machine shown in Fig. 7. In this illustration, stop *A* is used for limiting the distance through which the table travels, this stop being set to allow the table to drop just after the work has passed from under the cutter. The table is pivoted at the front end, and the dropping of the rear end to enable the work to clear the cutter is effected by means of a cam mechanism located beneath the table. Then when the table has been returned to the starting point, it engages another stop which brings the cam once more into operation, with the result that the table is lifted back into the working position.

All gears are completely guarded so that danger of injury to the operator is avoided. An improvement has been made in the method of adjusting the position of the head spindle and cone pulley, the design being such that when a change is made in the setting, the belt tension is automatically regulated to the desired point. The fixtures are usually designed to hold two rows of pieces and the cutters are mounted on an arbor supported on centers, so that the whole set of cutters can be removed and ground and then put back on the machine without loss of time in resetting the tools.

These are manufacturing machines which have been designed to take advantage of principles that have proved their efficiency by the successful results obtained with machines of similar construction used in manufacturing automobile parts and other products where rapid production and accuracy are points of primary importance.

PERSONS-ARTER MAGNETIC CHUCKS

The increasing use of grinding machinery and the greater demand for magnetic chucks for holding work, has led the Persons-Arter Machine Co., Worcester, Mass., to place a line of magnetic chucks on the market. In this article the rotary style magnetic chuck is shown in Fig. 1, and the construction is well illustrated in Fig. 2. In addition to the rotary style chuck, a flat type of chuck is also being brought out. The rotary chuck can be furnished in diameters from 6½ to 24½ inches; and the flat style chuck is made in sizes varying from 5 by 5¾ inches to 13 by 51 inches. The principal features claimed for the Persons-Arter magnetic chuck are simplicity of construction, low current consumption and high magnetic power.

Fig. 1. Rotary Magnetic Chuck made by Persons-Arter Machine Co.

From the illustration Fig. 2, it will be seen that there are but two poles in the entire chuck face. This face formation of

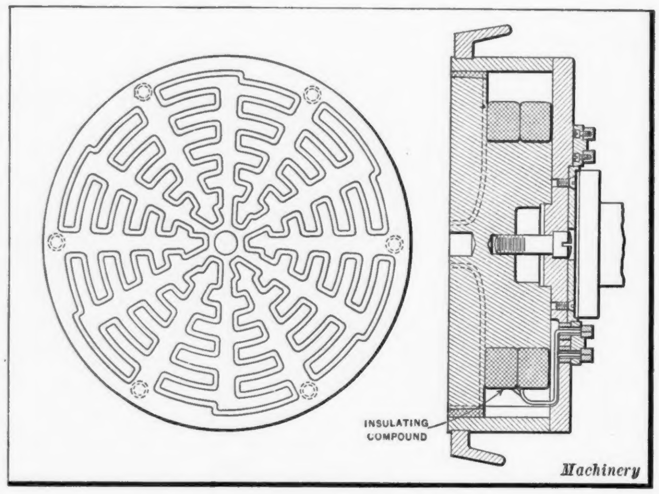


Fig. 2. Cross-sectional View showing Construction of Chuck

the chuck is a strong feature, and comprises one of the reasons for its high magnetic power. The air gap between the two poles is filled with a non-magnetic expanding metal composed of bismuth, antimony and lead. The chuck consists of but three principal parts, namely, the baseplate, the shell which comprises one of the poles, and the core that forms the second pole. The two pole castings are made of a special magnetic steel that is cast to the desired shape. This metal has a permeability nearly equal to the best Swedish iron.

The coils are two in number, as may be seen in the cross-sectional view, Fig. 2, and are very nearly the same diameter as the chuck. By using but two coils, it is possible to wire them in series for 220-volt current or in parallel for 110-volt current. These coils, after being wound and covered, are dipped in a high insulating compound and made water-proof. The leads from the coils run through a cored section of the baseplate to the collector rings on the bottom of the chuck, as shown in Fig. 2. The space around the magnetic coils is filled with an insulating compound of wax; and the ends of the leads are soldered into bushings that are driven into the collector rings, thus giving a good connection. The collector rings are mounted in a fiber ring, which, in turn, is fastened to the chuck base. The chuck is mounted on the spindle of the grinding machine through a spindle plate that is screwed to the under side of the chuck.

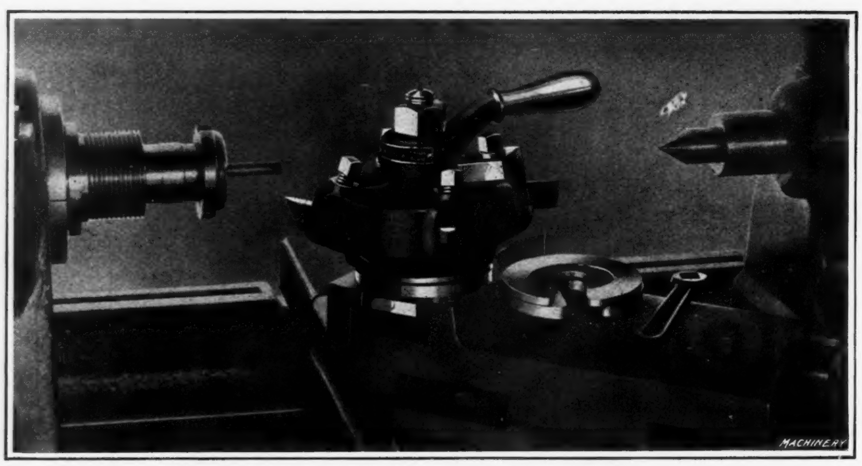


Fig. 1. F-P-M Style C Turret Tool-holder set up on a Lathe

Between the spindle plate and the baseplate of the chuck there is a brass insulator disk that prevents any magnetism from leaking into the chuck spindle. Surrounding the entire chuck near the top face is a water guard or flange whose purpose it is to keep the lubricating compound away from the chuck and grinding machine spindle. In recent tests that were made with a 12-inch rotary chuck taking 60 watts, it was found that a disk having an area of 1 square inch, resisted a pull of 190 pounds. It was also found that this pulling power was equally well exerted either at the edge of the chuck or at the center.

F-P-M TURRET TOOL HOLDER

Reference to Figs. 1 and 2 will make it evident that the F-P-M turret tool-holder, which has recently been placed on the market by the McCrosky Reamer Co., Meadville, Pa., is vir-

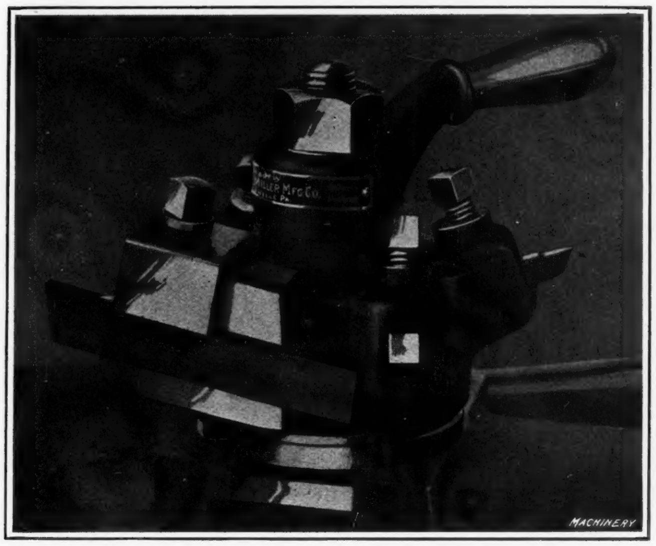


Fig. 2. Close View of Style C Turret Tool-holder with Cut-off Tool at Front

tually a combination of four tool-holders into a lathe turret. Small bits are employed, which are made of high-speed steel, so that advantage is taken of the economy obtained through the use of tool-holders; and the provision of mechanism for indexing the F-P-M tool-holder to bring successive tools into the operating position enables it to perform the function of a lathe turret. The tool-holder is made in two types known as styles C and D. Style C is provided with three square bits and a cut-off tool, and style D is furnished with two square bits and a cut-off tool; each style is made in four different sizes which

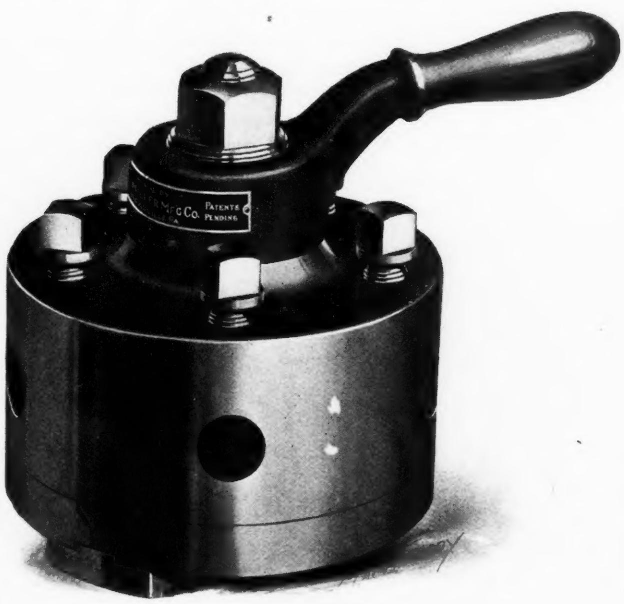


Fig. 3. F-P-M Style E Turret for Internal Work

take square bits 5/16, 3/8, 7/16 and 1/2 inch in size. The attachment is mounted upon the compound rest in the same way that an ordinary toolpost is secured, making it unnecessary to remove the compound rest from the cross-slide.

Fig. 3 shows what is known as the F-P-M style E turret which is designed to meet the requirements of inside work such as drilling, boring and reaming. This attachment may be quickly secured to the compound rest in the same way that the styles C and D turret toolposts are attached. The indexing plunger operates automatically when the clamping handle is tightened or loosened. Unless otherwise specified, the turret is furnished with five holes. The turret is $6\frac{1}{2}$ inches in diameter and the holes are $1\frac{1}{4}$ inch in diameter.

NEW BRITAIN TOTE BOXES

An addition to the line of shop furniture made by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., is the type of tote box shown in the accompanying illustration. The primary requisites of a tote box are strength, durability and a shape that permits of close nesting for convenience in transportation and storage. The New Britain tote boxes are made from 18 gage sheet steel and are of one-piece construction except for the handles which are of 16 gage stock, folded double to afford a comfortable hand-hold and welded in place.

The box is constructed of a single piece of sheet metal, the sides being folded over onto the end, which is formed by turning up the bottom. The edges of the stock at the sides and ends are turned over to form hems, which precludes the possibility of injury to a workman's hands through careless handling. By folding the edges of the stock over to form the top edge of the box, the corners are much stronger because the metal is of quadruple thickness at these points. This quad-

Tote Boxes made by the New Britain Machine Co.

ruple thickness is obtained because the side hem is continuous and runs under the end hem at each corner. The high location of the handles permits close nesting, and a hole is punched in each handle for convenience in pulling the box along the floor with a hook. On account of the one-piece construction, the box is liquid-tight; all laps and folds on the ends are electrically welded, forming a box that will be found very convenient and of unusual durability.

FENN TAPPING MACHINE

The No. 1 tapping machine which forms the subject of the following description is a recent product of the Fenn Mfg. Co.,

No. 1 Fenn Tapping Machine with Friction Drive

516 Asylum St., Hartford, Conn. This little machine is suitable for tapping holes up to 3/16 inch in diameter. A feature of the design is that the spindle is driven forward and reversed by friction, making the operation so sensitive that the breakage of taps is reduced to a minimum. The position of the friction rolls is adjustable, which affords a simple means of making speed changes and allows the operator to back out the tap at a greatly increased speed. With a countershaft speed of 300 R. P. M., the minimum speed of the spindle is 225 R. P. M., and the maximum speed, 600 R. P. M. Any speed may be obtained by adjusting the position of the friction rolls. The principal dimensions of the machine are as follows: maximum distance from chuck to table, 3⅞ inches; distance from upright to center of spindle, 3 inches; speed of countershaft, 300 R. P. M.; available spindle speeds, from 225 to 600 R. P. M.; and weight of machine and countershaft, 62 pounds.

Fig. 2. Arrangement of Chaser Guides in Rickert-Shafer Threading Die

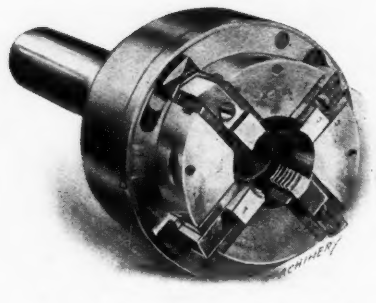


Fig. 3. View of Chaser Guides with Chasers and Carriers in Place

ENTERPRISE BENCH DRILL

The No. 1 "Emco" bench drill which has recently been developed by the Enterprise Machinery Co., 32-34 South Clinton St., Chicago, Ill., is particularly adapted to the requirements of shops doing tool and experimental work, although it is also suitable for many lines of light manufacturing work. The spindle is supported in double bearings, and the feed rack and pinion have cut teeth. The spindle is counterbalanced by a weight inside the column of the machine. The illustration shows the standard equipment furnished, and it will be seen that this includes an attached countershaft and a V-block which is substituted for the table when the machine is used for drilling transverse holes in shafts or other cylindrical work. This drill is adapted for running at speeds from 1500 to 5000 revolutions per minute. The principal dimensions are as follows: maximum travel of spindle, 3¾ inches; maximum adjustment of table, 4 inches; swing, 9¾ inches; capacity, for driving drills up to ⅜ inch; and weight, 48 pounds.

No. 1 Bench Drill built by Enterprise Machinery Co.

RICKERT-SHAFER AUTOMATIC THREADING DIE

The Rickert-Shafer Co., 1302 Peach St., Erie, Pa., has recently added to its line the Boehm automatic threading die illustrated and described herewith. The chasers have the necessary radial movement to enable the die to open after the threading operation has been completed, and they are supported by a cam ring throughout their entire length and width. The chasers slide between hardened and ground guides, and are supported by carriers which have a groove in the outer end for the positive opening cam. This cam is of the face type and is milled on the under side of the cam ring which is located in the closed position by two hardened locking pins that slide in hardened bushings and engage hardened plugs. The action of the locking pins is entirely independent of the rest of the die mechanism so that the die-head is allowed to come to the back position before closing. The die-head is driven by three hardened rollers which are located at the extreme outside of the shank head in order to eliminate torsional strains.

The floating die has a lateral float of from ⅛ to ¼ inch according to the size of the die, and is provided with an adjusting ring by means of which all the float may be taken up and the die made to cut threads as short as 3/32 inch. By means of this float, any error in the camming of automatic or semi-automatic machines is taken up by the die-head; and when used in hand machines, the operator is able to watch the float and so tell when he is forcing the die or when he is letting it drag. In this way a conscientious operator will be able to prevent spoiling any work, as well as opening the die before the proper length of thread has been cut. These die-heads are made in eight sizes which have capacities for threading work from ⅜ inch up to 2½ inches in diameter. They may be provided with or without float, and a taper attachment may be furnished.

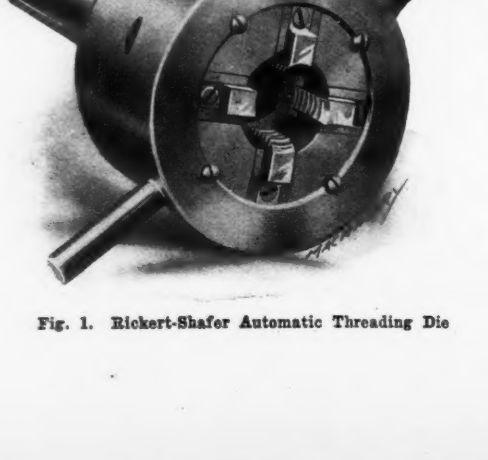


Fig. 1. Rickert-Shafer Automatic Threading Die

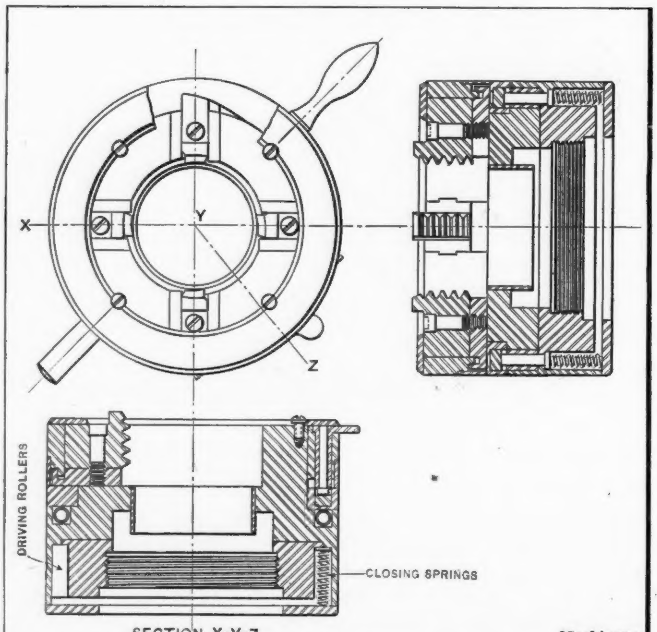
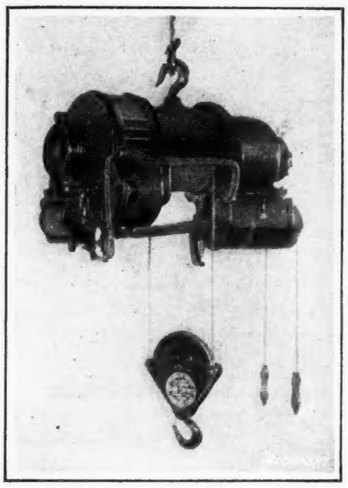


Fig. 4. Views showing Arrangement of Cam, Driving Rollers, Opening Springs, etc.

FRANKLIN MOORE ELECTRIC HOIST

The Franklin Moore Co., Winsted, Conn., is now manufacturing a line of motor-driven hoists which are built in sizes



Electric Hoist made by Franklin Moore Co.

having capacities of from 500 up to 10,000 pounds. A noteworthy feature is that each size of hoist is furnished with a different size of motor which gives exactly the required amount of power to lift the maximum load at an efficient speed, but does not add unduly to the weight. The mechanism of these hoists has also been very carefully designed so that they are capable of operating at a high efficiency. The hoist is compactly built, thus effecting a material saving in space, particularly in the amount of head room required.

The hoist built with a plain trolley has a complete weight of 225 pounds, which makes the operation of the trolley very easy. It has steel gears with cut teeth, which operate in an oil bath so that ample lubrication is insured. The rope drum is supported on roller bearings, and the hoist is supplied with a floor-operated controller, an automatic stop, and both mechanical and solenoid brakes.

Owing to certain mechanical features, the DC type of hoist is capable of giving exceptionally satisfactory results in foundries. The method of control makes it possible to raise and lower the load to within a small fraction of an inch of the required position, and the control operates without the least shock which would have a tendency to destroy molds. This hoist is of the hook type, but can be furnished with a plain, geared, or motor-driven trolley, with either floor or cab control.

RIVETT SELF-CENTERING BUSHING CHUCK

The difficulty of securing a chuck for adequately holding thin bushings for boring or internal grinding has led to the development of a self-centering bushing chuck by the Rivett Lathe &

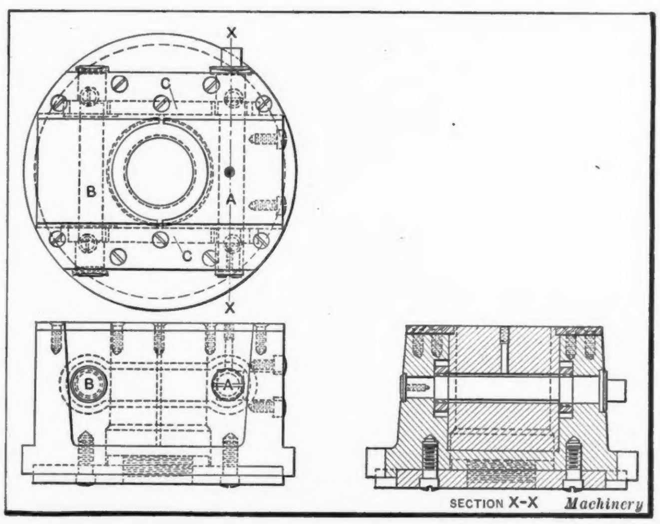


Fig. 1. Plan, Side and Cross-sectional Views of Self-centering Chuck

Grinder Co., Brighton, Boston, Mass. This chuck, which is shown in the accompanying illustrations, is designed to take a bushing of a given size and hold it from the outside in such a manner that distortion is impossible. It has two jaws, the total travel of which is not over 1/16 inch. Turning the chuck wrench moves both jaws simultaneously, and the bushing is thus automatically centered and powerfully gripped by the chuck.

Referring to Fig. 1, the construction and operation of this chuck may be followed. The body is of cast iron; and the two chuck jaws are very deep, having in the case of the chuck shown, a bearing of 2¾ inches on the bushing to be held. The jaws slide in the wide slot cut through the body of the chuck. At right angles to the travel of the jaws are the two spindles through which the movement of the jaws is secured. Spindle *A* is the one from which the chuck jaw operation is secured. This spindle is turned through the medium of the socket wrench shown beside the chuck in Fig. 1. The outer ends of this spindle are fitted closely in the body of the casting, while the central section is slightly eccentric, so that as the spindle is turned, the jaw through which this spindle passes will be reciprocated. It should be explained that the hole through this jaw is relieved vertically so that the eccentricity of spindle *A* moves the chuck in a longitudinal direction only.

The reciprocation of the second jaw is secured through spindle *B*. This spindle, it will be noted, is a short one and fits closely in the jaw, extending a slight distance on each side. The ends of this spindle *B* are connected with spindle *A* by means of links *C*. The sections of spindle *A* over which links *C* fit are eccentric but in an opposite direction from the eccentricity of the central portion of spindle *A*. As these links fit closely over the eccentric portion of spindle *A*, any rotation of this spindle imparts a longitudinal movement to links *C*. Because the eccentricity of the link bearings is opposite to that of the central section of the spindle, it is obvious that when the eccentric section of spindle *A* throws the jaw forward, the links *C*, and consequently spindle *B*, are pulled toward spindle *A*, and thus the second jaw is closed in simultaneously with the first one.

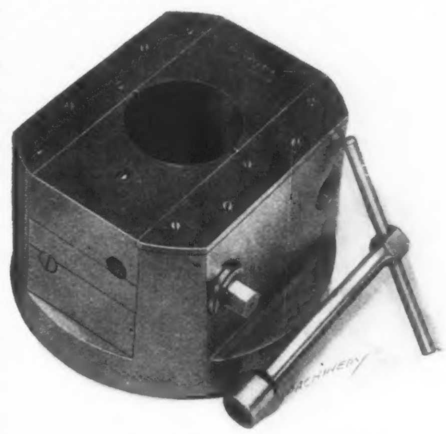


Fig. 2. Rivett Self-centering Bushing Chuck

The jaw opening motion is, of course, exactly the opposite in action. In the finished chuck, this mechanism is entirely enclosed, as Fig. 2 shows, so that there is no chance for injury or misuse. The features of this chuck are simplicity of operation, compact and foolproof form, and powerful and non-distorting grip upon the work. The chuck is intended for use on any lathe or grinder, and is fitted by means of threads that engage the spindle nose of the machine on which it is to be used. Two sizes are at present on the market, the maximum of which is the one shown, that takes bushings up to 2 9/16 inches external diameter. The smaller size accommodates bushings up to ¾ inch diameter. It is apparent that this chuck will not hold work that does not run uniform in diameter. For sizes smaller than the minimum size of the chuck, split cast-iron bushings are employed.

PAJARO MAGNIFYING MIRROR

For the use of toolmakers and machinists, the Pajaro Mfg. Co., Erie, Pa., has developed a magnifying mirror that is used in obtaining a clear view of work or tools which cannot otherwise be seen without straining the eyes or getting into an uncomfortable position. The mirror is 2 3/16 inches in diameter

Fig. 1. Pajaro Magnifying Mirror for Toolmakers and Machinists

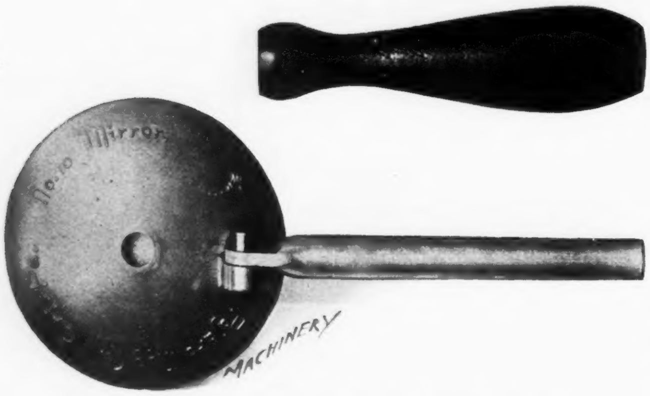


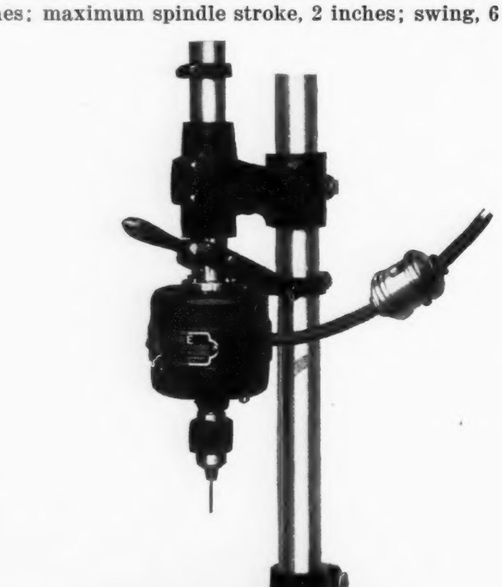
Fig. 2. Back View of Mirror showing Handle removed

and ground concave to give a high magnifying power; it is mounted in a white metal die-casting, and provided with a hardwood handle.

Among the uses of this mirror the following may be mentioned. Suppose you wish to see the cutting edge of a forming tool mounted in the lathe or shaper. It is merely necessary to hold the glass in front of or under the tool. Similarly, in cutting an internal thread which is not plainly visible, the mirror may be held in such a position that it will reflect sufficient light into the hole to give a clear view. In short, the tool is used whenever it is required to get a clear view of the work, and when the light, position or other circumstances make the obtaining of such a view a difficult matter.

WISCONSIN SENSITIVE DRILL

For the performance of drilling operations which require the use of a high-speed sensitive drill press, the Wisconsin Electric Co., Racine, Wis., has added to its line of "Dunmore" tools the bench drill which is illustrated and described herewith. This drill is especially adapted for the work of jewelers, watchmakers, instrument manufacturers, goldsmiths and silversmiths. It is driven by a direct-connected motor and equipped with a 13/64-inch Jacobs drill chuck. The feed control is equipped with a spring balance and is extremely sensitive, making the machine suitable for operation on the most delicate classes of work. The drive is from a high-speed universal motor capable of operating satisfactorily on either direct or alternating current, and it is equipped with S. K. F. ball bearings. The principal dimensions are as follows: height, 18 inches; maximum spindle stroke, 2 inches; swing, 6 inches; capacity for drilling in steel, up to 3/32 inch; capacity for drilling brass, bronze and soft alloys, up to 13/64 inch; and weight, 15¾ pounds.



High-speed Sensitive Bench Drill made by Wisconsin Electric Co.

LARSON BELT SHIFTER

It will be evident from the illustration which accompanies this article that the belt shifter shown on an upright drill press provides a quick means of shifting the belt from step to step of the cone pulley; the shifter is equally applicable for use on all classes of cone-driven machine tools. It is of simple construction, consisting of only five parts: the vertical shifter rod and handle *A* are a single unit; pivot rod *B* is screwed into the rear of the drill press column; belt loops *C* are secured to the shifter rod by set-screws; retaining strap *D* is secured to the column of the machine and limits the movement of the handle. Viewed from the top of the machine, pivot rod *B* is parallel with the corners of the cone steps on the belt entering side and by sliding the handle on this rod, the shifter loops are moved in a way that enables them to move the belt easily from one step of the pulley to another. It will be seen that the handle *A* projects beyond the shifter rod and this handle is bent over to form a shoulder in which is drilled a hole to admit the pivot rod *B*.

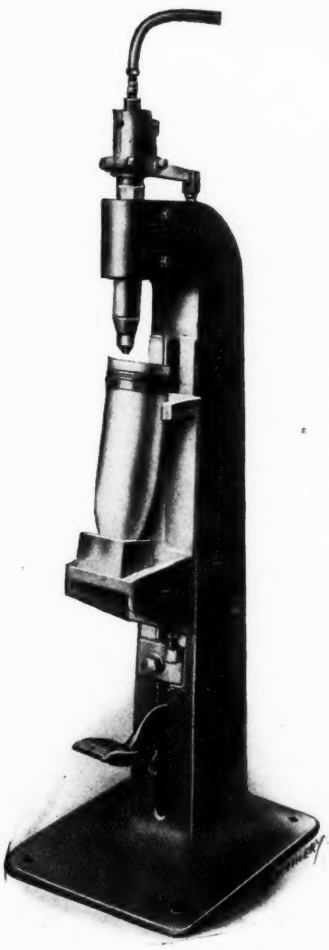
Drill Press equipped with Larson Belt Shifter

In operation, a slight pull forward and upward causes the belt to shift from the lower large cone step, and a second pull forward and downward shifts the belt onto the corresponding small step on the upper pulley. It will be obvious that this device is the means of saving time because it can be worked with one hand and is within convenient reach of the operator when he is at the front of the machine. If it is desired to shift the belt from one end of the cone pulley to the other, it is unnecessary to shift it from step to step; in such a case the operator simply pulls or pushes the handle to the limit of its movement in the proper direction, stops being provided so that the handle cannot be moved far enough to throw the belt off the pulley. This belt shifter is made by Nils E. Larson, 226 N. Hamlin Ave., Chicago, Ill.

GRANT PNEUMATIC SHELL RIVETER

For use in securing the gas check plug in shells which have an annular rim turned on the base of the shell to provide metal for closing down over the edge of the gas check plug before the base of the shell is faced off, the Grant Mfg. & Machine Co., N. W. Station, Bridgeport, Conn., has added to its line a stationary type of pneumatic riveter which is illustrated and described herewith. The operation performed on this particular type of shell requires the displacement of a considerable quantity of metal in order that the plug may be firmly held after the base of the shell has been faced off, without the joint being visible. The Grant riveting machine is equipped with a special supporting table and fixture which receives the nose of the shell, so that the base is supported in the proper position under the hammer.

The riveter is of the stationary type, and is fitted with a foot treadle which is used to bring the riveting hammer into action, leaving both of the operator's hands free for handling the work. After the shell has been placed in position, the treadle is depressed to start the hammer and the shell is then rotated by hand through one complete revolution. The hammer delivers about 1000 blows per minute and the plug can be riveted perfectly tight in about twenty seconds. These machines are built for handling 4.5, 5 and 6 inch shells, and are also adapted for ordinary riveting operations on rivets up to ½ inch in diameter. The principal dimensions are as follows: diameter of piston, 1 1/16 inch; length of stroke, 4 inches; volume of air taken per minute, 18 cubic feet; pressure of air, 80 to 100 pounds per square inch; speed, 1000 blows per minute; and weight of machine, 300 pounds.

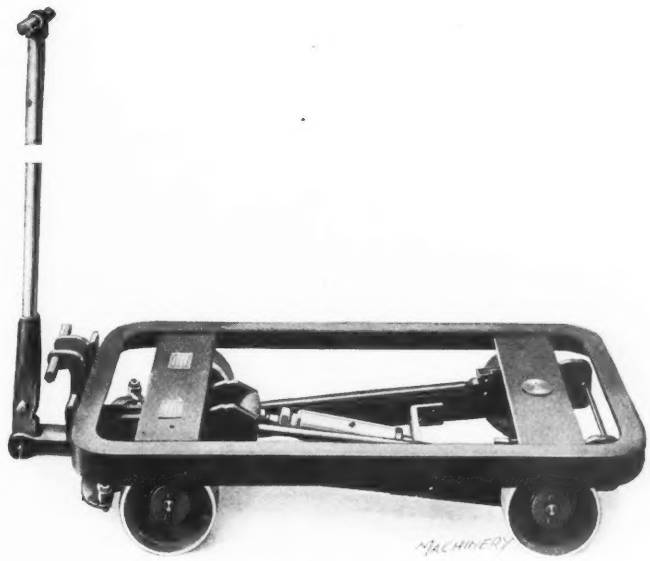


Grant Pneumatic Riveter for closing in Metal around Gas Check Plugs

PLIMPTON TRANSFER TRUCK

The Plimpton Transfer Truck, 70 Fifth Ave., New York City, is now manufacturing the transfer truck shown in the accompanying illustration. It will be seen that this truck is constructed to take advantage of the elevating principle, the work being stacked on rough wooden platforms preparatory to being moved. As previously pointed out in these columns, this type of truck saves a considerable part of the investment for equipment required to transfer work from one department of the factory to another, as it is only necessary to provide the number of trucks which are actually required for moving the work.

In elevating the truck, a link on the elevating mechanism is hooked over a pin on the handle, after which the handle is pulled forward to a horizontal position. This results in raising the load and locking the mechanism in the raised position, after which the handle may be lifted to the position which is convenient for pulling the truck. To release the load, the handle is raised and pressed against projecting cam rods on the elevating mechanism, which results in releasing the check and permitting the load to descend slowly to the floor without the least shock. The truck is said to be rigidly constructed to adapt it for successful operation under severe conditions of service. The Plimpton transfer truck is made in six different sizes, with capacities for handling loads ranging from one to three tons.



Plimpton Elevating Transfer Truck

BLOMQUIST-ECK SENSITIVE DRILL

One of the latest additions to the line of machines manufactured by the Blomquist-Eck Machine & Mfg. Co., Cleveland, Ohio, is the No. 1 sensitive bench drill shown in the accompanying illustration. The following are features of the machine which give it extreme sensitiveness, and that add to its rigidity and freedom from vibration. All bearings are accurately ground to size and the pulleys are ground on the crown. The spindle is made of 40-point carbon steel and the end thrust is taken by a ball bearing. The spindle is carried by long bearings, which insure holding it in perfect alignment; and it is bored No. 1 Morse taper.

The surface of the table is accurately ground so that it is within 0.001 inch of true in all places. Two changes of spindle speed are provided, and the machine is driven by a 1½-inch belt. The principal dimensions are as follows: maximum distance from spindle to table, 12 inches; vertical movement of spindle, 3½ inches; hole in spindle, No. 1 Morse taper; vertical movement of table, 6 inches; size of table, 11½ inches square; distance from center of spindle to frame 7⅜ inches; driving

No. 1 Sensitive Drill made by Blomquist-Eck Machine & Mfg. Co.

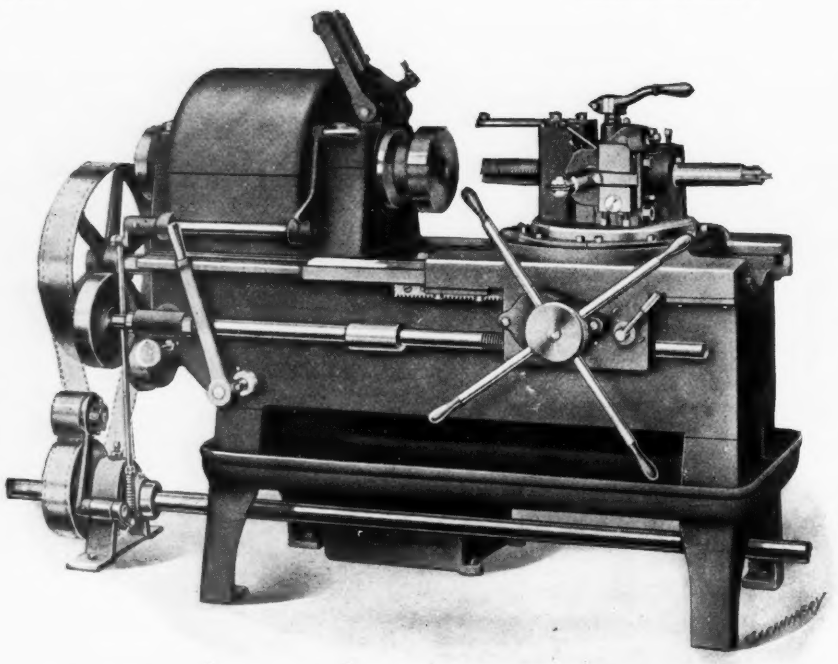


Fig. 1. Blood Turret Lathe for machining 3-inch Shrapnel and High-explosive Shells

capacity, for drills up to ½ inch in diameter; speed of driving pulley, 550 revolutions per minute; weight of bench drill, 110 pounds; and weight of machine arranged with floor column, 215 pounds.

DODGE SHELL TURNING LATHES AND TOOLS

One of the latest additions to the long list of special machinery for use in manufacturing shells is the line of machines that has recently been placed on the market by H. C. Dodge. It consists of a turret lathe for machining 3-inch shells; a turret lathe for machining shells up to 6 inches in diameter; a machine for performing filing, burring and polishing operations on shells; and a vise for holding shells while tapping, reaming, inspecting, etc. These are simple, rigid machines adapted for the conditions commonly met with in munition factories, and a general conception of their features will be readily obtained by reference to the illustrations.

H. C. Dodge, 175 Old Colony Ave., South Boston, Mass., has designed and placed on the market for use in the shell manufacturing trade, the lathes and tools described in this article. They were designed from experience secured in actual shell manufacturing, and their characteristics are stiffness and freedom from all features not actually required for the work to be done.

The first of these lathes, which is called the Blood single-purpose lathe, was designed by Charles Blood and is manufactured under his patents. A front view of this machine is illustrated in Fig. 1, and a rear view in Fig. 2. This lathe is intended for the sole purpose of machining high-explosive or shrapnel shells of the 3-inch or 75 millimeter size. It is essentially a single-purpose machine, and therefore does not include many of the features of the ordinary lathe. In designing this machine, special attention was paid to securing the greatest strength possible for the operations to be performed, keeping the machine as compact as possible. This will be understood when it is stated that the machine occupies a floor space of only 6 feet by 2 feet, 6 inches. The weight is 2300 pounds.

While this machine can be driven from an overhead lineshaft if desired, a more compact method, especially when the machines are used in batteries, is the one illustrated in Fig. 1. Here the lineshaft is shown beneath the machine and it will be evident that a large number of machines can be operated in a small space. From the driving shaft, rotation is transmitted to the main spindle by direct gearing. The lathe is started or stopped by pulling down on the crank that may be seen directly in front of the headstock, which operates an idler acting directly upon the driving belt. The drive gears are two in number, so that two speeds are obtainable, the ratio of the speeds being 4 to 1. The driving gears are of steel with faces 2¼ inches in width, thus supplying plenty of power for the spindle drive.

The spindle is 5½ inches diameter, has a 3-inch hole running through it, and runs in long bearings that are lined with babbitt which is pressed into dovetail slots and scraped to fit the spindle. The spindle nose is fitted with a draw-in type of chuck that is very powerful in its operation. The feed is obtained from the feed shaft at the front of the machine, and this receives rotation from feed gears within the machine that are direct-connected with the driving shaft. The ways are very widely spaced and the carriage bearings are extremely long. The carriage is power-traversed by engaging a worm on the feed shaft with a worm-wheel within the apron which operates in the usual way. The travel of the turret is limited to 15 inches, as this covers the greatest tool travel required on any 3-inch shell. For hand operation, a large pilot wheel is used.

The circular bearing of the turret upon the carriage is of large size, giving ample support to the cutting tools. The withdrawal of the turret on the carriage automatically releases a locking pin, so that the turret may be revolved from station to station. The tools for performing turning or boring operations are located on the turret; and in manufacturing shells it is customary to use the machines tooled for outside turning, for inside boring, and for machining the nose. In each case the machine is the same, but the chuck and turret equipment is suited to the operation to be performed. As an example of the way the Blood single-purpose lathe is being used in one large shell manufacturing plant, it may be stated that in rough-turning shells, taking ¼ inch off the diameter, the length of 6¼ inches is turned in forty-five seconds.

Dodge Special Single-purpose Lathe

The shell manufacturing lathe illustrated in Fig. 3 is known as the Dodge single-purpose lathe and is intended for machin-

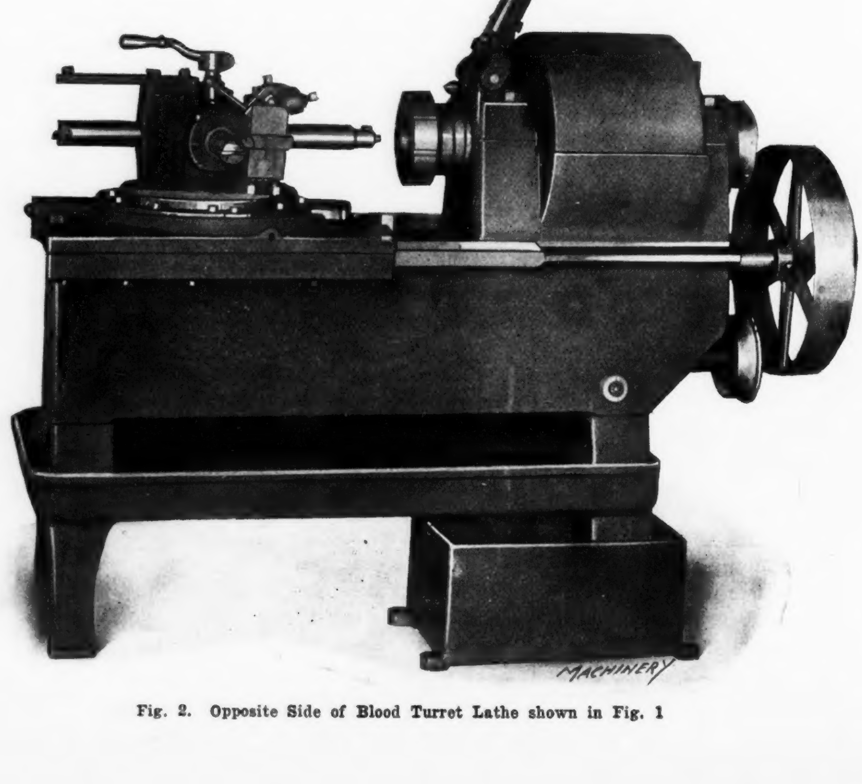


Fig. 2. Opposite Side of Blood Turret Lathe shown in Fig. 1

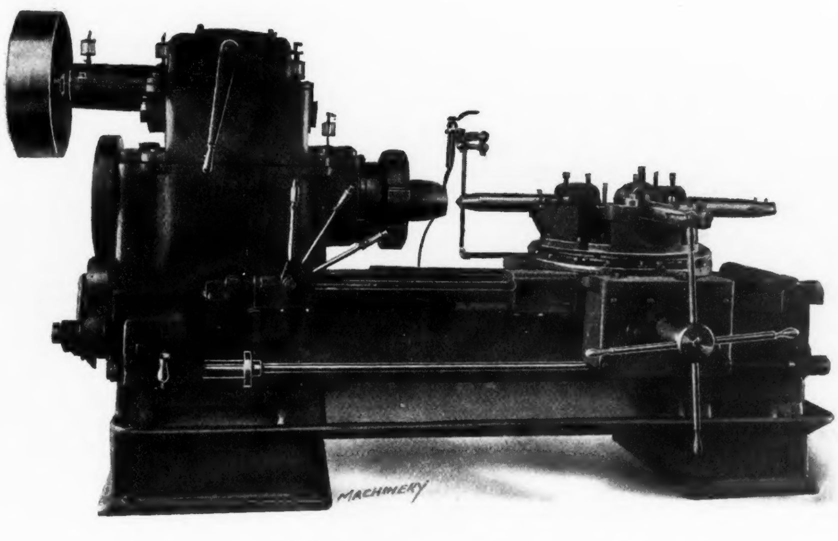


Fig. 3. Dodge Turret Lathe for machining Shells up to 6 Inches in Diameter

ing shells in any diameters up to 6 inches. It will be seen that this lathe is of the turret type, and as it is for the sole purpose of shell manufacturing, all the usual lathe features not required for this class of work have been omitted. In the design of this machine the principal objects strived for were strength and power for carrying heavy cuts, and convenience of operation.

The drive is through a 16-inch pulley having a 5½-inch face, from which power is transmitted through direct gearing to the spindle. The spindle bearings are of ample size, the one at the front being 9½ inches diameter by 8 inches long, and the one at the rear, 7½ inches diameter and 7 inches long. The spindle bearings are lined with babbitt which is compressed into dovetail grooves. The spindle is provided with a hole large enough to receive a 6-inch shell at the front end; and the headstock in which the spindle is mounted is extremely heavy and bolted to the bed. Two changes of speed are provided in the head, and by using a two-speed countershaft, four speeds are obtainable. A collet chuck of heavy design is employed for holding the shell while machining the inside, and for outside work the proper type of expanding mandrel is supplied.

The bed is comparatively short, being 8 feet, 6 inches in length; it is designed on extremely heavy lines, and is ribbed and provided with a chip pan for catching chips and lubricant. The base of the machine at the forward end contains an oil tank for lubricant. The floor space required for the machine is 4 by 10 feet. The ways are spaced 27 inches apart; the front way is of the V-type and the rear way is flat. The carriage has a bearing 40 inches long on the ways, and it is securely gibbed at the back to prevent lifting. The extreme travel of the carriage is 30 inches. The circular bearing of the turret on the carriage is 24 inches in diameter, and the turret is held at the various stations by a hardened steel locking pin that fits in tapered steel bearings. Owing to the large diameter of the turret, there is plenty of room for mounting the various tools, regardless of whether they are used on inside or outside work. The locking pin is disengaged by a conveniently located lever. The lathe swings 24 inches over the ways and 6 inches over the turret.

The feed is secured from the gear-box at the left-hand end of the machine. From the feed-shaft at the front, a worm engages a bronze worm-wheel in the apron of the carriage, which runs in oil. This drives a pinion that meshes with a rack which is inverted so that it does not become clogged. This rack is located well under the edge of the bed, thus counteracting any twisting tendency of the carriage. Three changes of speed may be secured, control being provided by a lever which actuates a sliding gear in the feed-box so that the feed changes may be made without stopping the spindle. An adjustable stop for each station of the turret automatically disengages the feed clutch just before the fixed stop is reached. This enables the operator to feed the last few thousandths inch by hand and guards against the breakage of tools, in addition to insuring exact duplication of limits. The Dodge single-purpose lathe is supplied fully tooled to perform any of the following operations: (1) outside turning of the shell; (2) inside boring, reaming and facing; (3) base forming, including turning and threading of the recess for the gas plug; (4) nose forming after the cap has been fitted in the nose of the shell.

Dodge Shell Filing and Polishing Lathe

The lathe illustrated in Fig. 4 is used for performing filing, polishing or burring operations upon shells of any diameter within its range. This machine is mounted on a bench and driven from beneath, as shown in the illustration. The lathe is stopped or started by the hand-lever shown at the left, which operates an idler beneath the bench; and the operation of this hand-lever also applies a brake to the spindle to stop rotation quickly. The tailstock is lever-controlled and the whole apparatus was designed for the rapid handling of shells on short filing and polishing operations for removing tool marks, cleaning up the copper band, polishing the nose, etc.

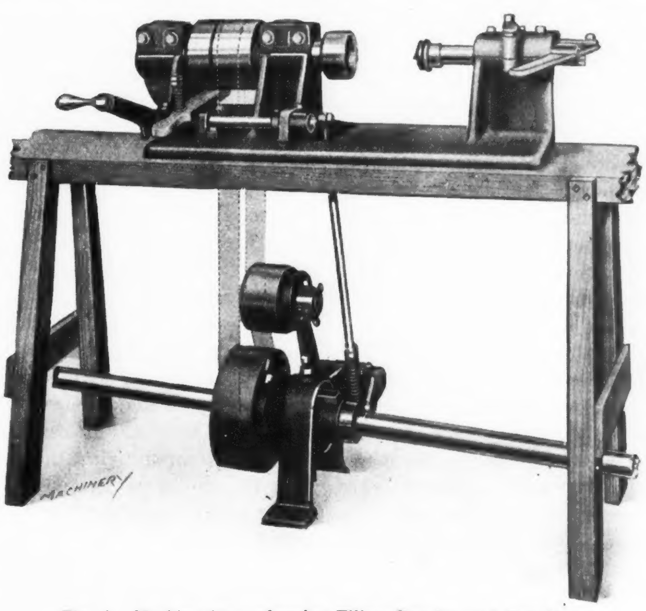


Fig. 4. Machine for performing Filing, Burring and Polishing Operations on Shells

Vise for Holding Shells

The vise illustrated in Fig. 5 was placed on the market for use in holding shells while reaming, tapping, inspecting, loading or performing other operations that require the shell to be held in a vertical position. It will be seen that the vise is intended to be screwed to a bench and that it is of the split type with the two halves hinged and held together by a bolt that has a nut operated by a handwheel. This vise is made for holding 3-inch shells and will grip them sufficiently for the heaviest tapping or reaming operations on the nose.

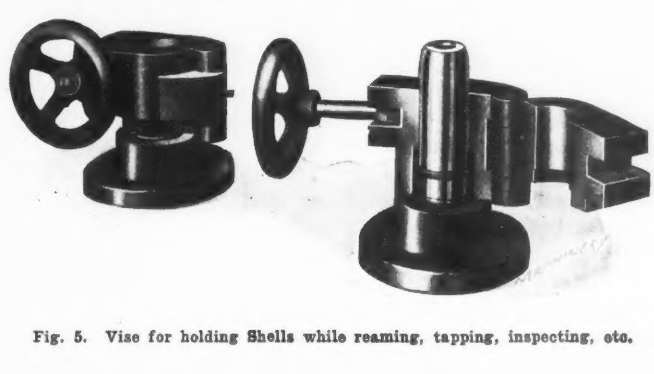
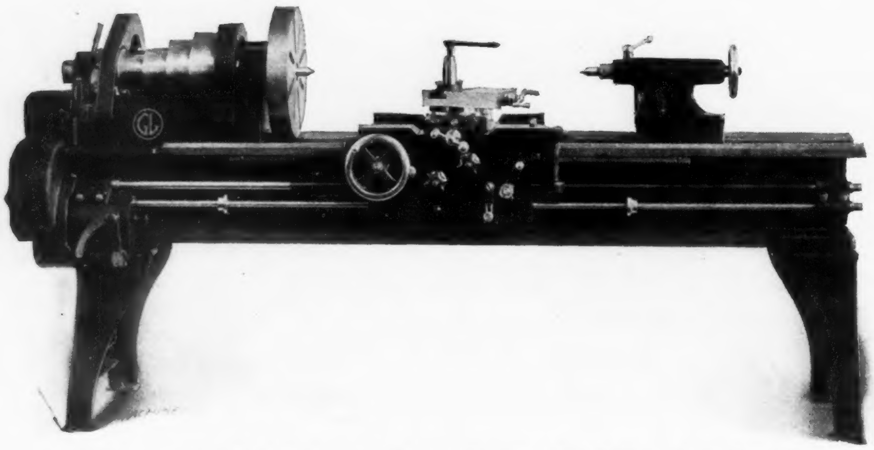


Fig. 5. Vise for holding Shells while reaming, tapping, inspecting, etc.



Giddings & Lewis 16-inch Lathe equipped with Four-step Cone Pulley and Single Back-gears

GIDDINGS & LEWIS LATHE

The Giddings & Lewis Mfg. Co., Fond du Lac, Wis., is now manufacturing a 16-inch heavy pattern lathe which is equipped with either a four-step cone pulley and single back-gears, or three-step cone pulley and double back-gears. Both types of lathes are built with positive geared feed. These are said to be strong and accurate lathes which are capable of giving satisfactory service in the tool-room or manufacturing departments of a factory, and they are adapted for handling either light or heavy work.

The spindle is turned from a crucible steel forging which provides ample strength and resistance against wear; it has a hole bored through it and is accurately ground to size. The spindle bearings are lined with phosphor-bronze and furnished with wick oilers that dip into a reservoir from which they deliver a constant supply of clean oil to the bearings at all times. Anti-friction thrust bearings are provided with a nut for adjusting them from time to time. The tailstock is designed in such a way that the compound rest may be set at right angles to the cross-slide; and the tail-spindle is made of steel, accurately ground and graduated in inches for the convenience of the operator when performing drilling operations on the lathe. Means are provided for setting over the tailstock for performing taper turning operations.

The carriage is gibbed to the bed at the front, center and back, and is scraped to provide a solid bearing over its entire length. The carriage is flat on top so that work may be clamped to it. Power longitudinal and cross feeds are provided, and the cross-feed screw has micrometer adjustment. When the cross-feed is in use, the carriage can be quickly clamped to the bed. The thread chasing dial is graduated to indicate the rotation of the lead-screw and enables the operator to throw in the nut at the proper moment, thus permitting him to return the carriage by hand. The compound rest is fitted with the usual form of taper gibs which require the use of only one screw in making adjustments.

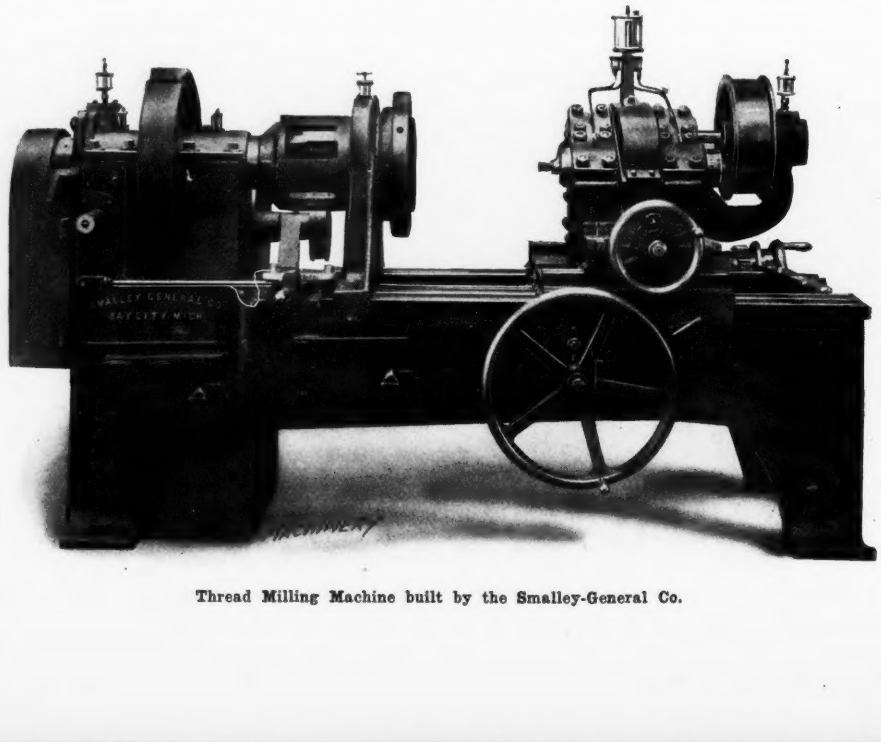
The apron is shouldered into the carriage and all parts are strongly constructed. The longitudinal and cross feeds are reversible from the apron, and the former is so arranged that it is impossible for the lead-screw and feed-rod to be engaged simultaneously. Both longitudinal and cross feeds are friction-driven and can be instantly thrown in or out, the frictions also serving as safety devices to protect the mechanism from damage. The automatic stop and feed reverse are controlled by a lever located near the bottom of the apron at the right, these mechanisms being used only for the turning feed; the reverse for screw cutting is obtained by shifting a lever located at the end of the headstock. The quick-change feed-box provides eight positive geared feeds, any of which may be instantly obtained.

The principal dimensions are as follows: swing over bed, 18⅜ inches; swing over rest, 11 inches; capacity between centers for lathe with six-foot bed, 29 inches; diameter of hole through spindle, 1½ inch; diameter of tailstock spindle, 2 1/16 inches; traverse of tailstock spindle, 7½ inches; range for screw cutting, 2 to 24 threads per inch; range of feeds, 0.010 to 0.051 inch per revolution; size of tools, ⅝ by 1⅛ inch; weight of machine with six-foot bed, 2281 pounds. The preceding dimensions apply to both the machine with a four-step cone and single back-gears, and to the machine with a three-step cone and double back-gears. On the machine with a four-step cone, the available speeds are from 6 to 385 R. P. M., the width of the driving belt is 3 inches, and the ratio of the single back-gears, 10 to 1. On the machine with the three-step cone, the available spindle speeds are 10 to 222 R. P. M., the width of the driving belt is 3½ inches, and the ratio of the double back-gears, 9 to 1 and 3 to 1.

SMALLEY-GENERAL THREAD MILLING MACHINE

The thread milling machine which forms the subject of the following article can be used on any kind of work where a straight thread is to be cut, although the machine is at present being used almost entirely on shell work. It is capable of handling pieces with from four to twenty threads per inch. The illustration shows the machine equipped with a collet chuck of the type used in threading the nose of 8-inch shells, but various other types of chucks can be furnished with the machine, the selection depending upon the size of shells to be threaded and the way in which the work is handled in the shop.

In working out the design, great care was taken to produce a machine which would be entirely free of vibration, and as simple as possible. With this object in view the main head is cast solid with the bed to insure permanent alignment. The cutter-head has broad ways with gibs for taking up wear. All bearings are lined with bronze and all gears are made of steel with teeth of ample size for the service. In order to avoid vibration in the cutter-spindle, herringbone gears are provided for transmitting the power from the pulley shaft to the spindle, and these gears run in oil. The head is oiled from a large sight-feed oiler, and all principal bearings have liberal sized oil cups. The oil holes are provided with self-closing covers wherever it is possible to apply them. For the purpose of keeping the ways clear of chips, wipers are provided which



Thread Milling Machine built by the Smalley-General Co.

can be seen in the accompanying illustration.

One of the principal features of the machine is the two-speed mechanism which is operated by throwing a lever located at the back of the steadyrest. This provides for instantly changing the speed from 6 inches per minute, which is the speed used for thread milling, to 25 feet per minute, which is the speed employed for scraping the plug seat to insure its alignment with the thread. For performing the scraping operation, a tool is provided at the back of the thread milling cutter so that the plug seat is scraped without removing either the scraping tool or the threading cutter from the cutter-head. The diameter of the thread is regulated by a micrometer screw. The feed-screw is furnished with a trip which throws out the clutch and prevents the slide from coming back against the shoulder, should the operator let the machine run too long.

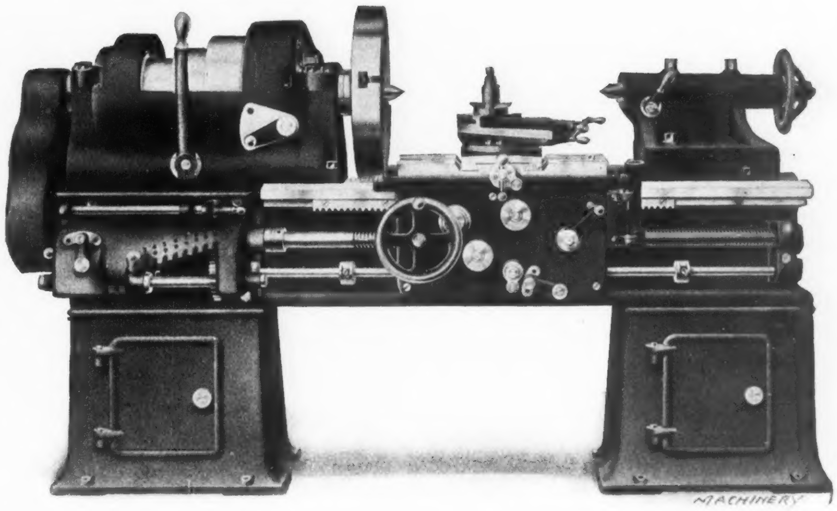


Fig. 2. Rahn 18-inch Engine Lathe equipped with Three-step Cone Pulley and Double Back-gears

Located in the base are a tank and lubricant pump which provide for delivering a copious supply of cutting compound to the cutter. After being delivered to the work, this cutting compound drops into a trough from which it drains back to the main reservoir. Three settling chambers are provided so that all chips and other foreign matter are removed from the cutting compound before it is again passed through the pump. It will be seen that there are doors at the front of the bed which permit of cleaning out the chips. In operating the machine, a milling speed of 6 inches per minute is usually recommended for handling work with eight threads per inch; but there are machines in successful operation on which the speed has been increased to 9 inches per minute, and they are said to be producing perfectly satisfactory results.

It will be evident from the illustration that the machine employs the so-called "hob" or multiple type of thread milling cutter which only requires the work to make one revolution to complete the milling operation. This type of machine has recently been described in these columns. The machines are built for any size of shells up to 16 inches; and they may be arranged for belt drive or individual motor drive, as required. The Smalley-General Co., Inc., Bay City, Mich., is the manufacturer of this thread miller.

RAHN ENGINE LATHES

The 18-inch engine lathes illustrated and described herewith have recently been placed on the market by John Rahn, Cincinnati, Ohio. It will be evident from the illustrations that the design of these two machines is the same with the exception of the headstocks; each type of headstock will be described in detail and the remainder of the description applies to both machines.

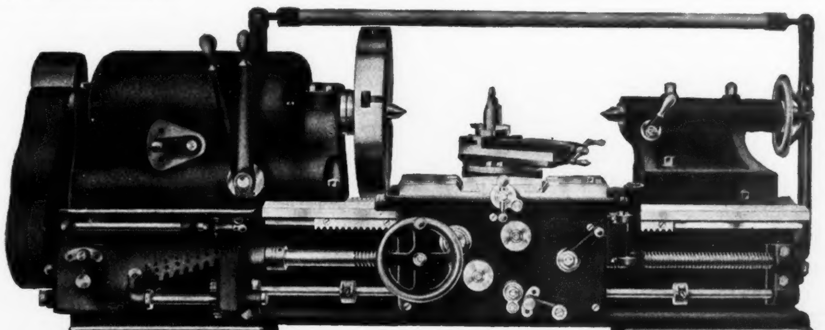


Fig. 1. Rahn 18-inch Engine Lathe equipped with Single-pulley Drive and All-geared Head

It will be seen that the lathe shown in Fig. 1 is equipped with single-pulley drive and a geared head. The gears run in oil so that they are thoroughly lubricated, and sixteen changes of speed are provided when the machine is driven by a double friction countershaft. The gears run in one direction, and the changes of speed are obtained through friction clutches and levers on the outside of the headstock, which enable the operator to change instantly from one speed to another without stopping the machine. The direction of rotation of the spindle is also reversed by means of a friction clutch connected to the spindle and controlled by the lever and rod which runs the entire length of the bed. The spindle is hollow and made of high carbon steel; it is supported in bearings lined with phosphor-bronze and provided with means of compensating for wear. The centers are No. 4 Morse taper, and they are hardened and ground to run perfectly true.

Fig. 2 shows the same lathe equipped with a three-step cone pulley and double back-gears. The spindle and spindle bearings are the same as in the geared-head lathe. The driving cone is of large size and transmits the power through back-gears which are constantly in mesh, thus obviating the necessity of throwing them in when it is required to use the back-geared drive. A steel pinion which engages the large spindle gear is thrown into mesh when it is desired to bring the back-gears into operation. Levers at the front of the headstock provide for instantly changing the speed, and these levers are within easy reach of the operator.

The tailstock is of the offset type which provides for setting the compound rest parallel with the bed, and is furnished with means of setting it over for turning taper work. The compound rest is rigidly constructed and has the usual arrangement of taper gibs for compensating for wear. The carriage is gibbed to the bed at front and back, and provided with a liberal sized bearing for the tool rest. Felt wipers assist in lubricating the bearings, and provision is made for applying a taper attachment. The apron is of the double-plate type and designed in such a way that all feed and screw cutting mechanism is conveniently controlled. All gears in the apron, as well as the rack, are made of steel. The lead-screw has Acme threads and the thrust is taken by ball bearings. All shafts in the apron are supported at both ends and run in bronze bearings. The pinion that meshes with the rack is supported at both sides and can be drawn out of mesh when the lathe is engaged in screw cutting. For performing the latter operation, a screw chasing dial is provided, which obviates the necessity of reversing the spindle when chasing threads. A safety device makes it impossible for the feed and screw cutting mechanisms to engage simultaneously.

The quick-change feed-box is of simple and

substantial construction, providing a range of thirty changes of feed by operating two levers on the outside of the box, which can be manipulated while the lathe is running. Means are provided for introducing the usual form of "translating" gears into the drive for cutting threads of any desired metric pitch which come within the range of the lathe. The lathe is driven by a countershaft with double friction clutch pulleys, ample oiling facilities being provided for the countershaft bearings. The regular equipment includes a countershaft, steadyrest, follow-rest, large faceplate, driving belt, screw cutting dial, and the necessary wrenches. When desired, a taper attachment, turret on the carriage, chucks, chuck plates, and any desired forms of turning tools may be furnished as extra parts.

The principal dimensions of both machines are as follows: diameter of hole through spindle, 1¾ inch; diameter of tail-spindle, 2⅛ inches; traverse of tail-spindle, 8½ inches; width of driving belt, 3 inches; range of threads that can be cut, 4 to 40 per inch; range of feeds, 0.010 to 0.110 inch per revolution; length of bed, 6½ feet; maximum distance between centers, 2 feet, 6 inches; swing over bed, 18½ inches; swing over carriage, 12 inches; swing over steadyrest, 11 inches; travel of compound rest, 6½ inches; size of tools used, 1¼ by ⅝ inch; floor space occupied by lathe with six-foot bed, 6 feet, 6 inches by 18½ inches; and weight of machine with six-foot bed, 2600 pounds.

PAWLING & HARNISCHFEGER CENTERING MACHINE

For centering shafts and other cylindrical work, the Pawling & Harnischfeger Co., Milwaukee, Wis., has placed on the market the duplex centering machine illustrated and described herewith. That the machine has a capacity for handling a wide range of work is well brought out by these illustrations. Figs. 1 and 2 show front and rear views of the machine working on a shaft 7¼ inches in diameter by 9 feet, 8 inches long, and Fig. 3 shows a partial rear view of the machine centering a shaft which is only 1⅛ inch in diameter by 30 inches long. This shows in a forcible manner the range of work for which the machine is adapted, although it does not represent the extreme range, as shafts varying in size from ⅞ inch in diameter by 10 inches long up to 7½ inches in diameter by 12 feet long can be centered. It will be seen from the rear views that the machine is equipped with individual motor drive, the motor being direct-connected to a driving shaft at the back of the machine. This shaft, in turn, is belted to the geared heads. When so desired, the machine may also be equipped for belt drive.

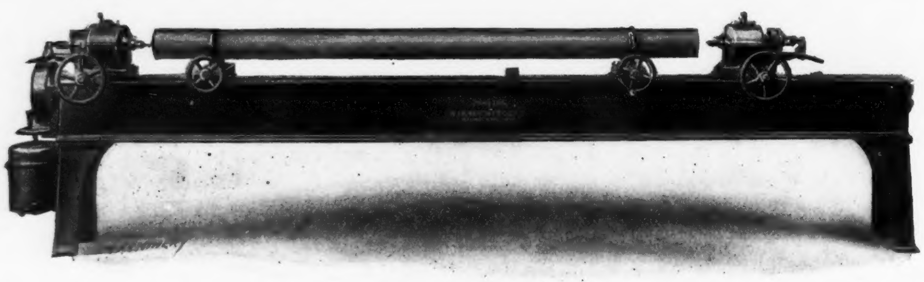


Fig. 1. Front View of Pawling & Harnischfeger Centering Machine working on Shaft 7¼ Inches in Diameter by 9 Feet, 8 Inches Long

The principal dimensions of this Pawling & Harnischfeger centering machine are: length over all, 16 feet, 6 inches; spindle bore, No. 2 Morse taper; drill spindle speed, 600 R. P. M.; reamer speed, 240 R. P. M.; speed of driving shaft, 400 R. P. M.; size of driving pulley for belt drive, 8 inches in diameter by 2¼ inches face width; capacity of motor used for individual motor drive, ½ horsepower; and weight of motor-driven machine, 2200 pounds. The regular equipment of the machine includes two drill chucks for ⅛-inch drills, two three-lipped center reamers 1 inch in diameter, and one supporting jack.

Fig. 2. Opposite Side of Pawling & Harnischfeger Centering Machine shown in Fig. 1

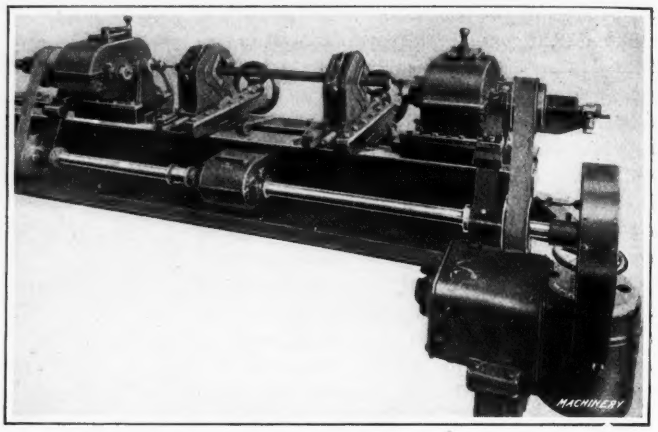


Fig. 3. Close View of Pawling & Harnischfeger Centering Machine working on Shaft 1⅛ Inch in Diameter by 30 Inches Long

CHAIN BELT PICKLING CONVEYOR

For some time the manufacturers of tubular brass goods and other metal products have felt the need of some form of mechanical conveyor for carrying the work through a series of pickling and rinsing baths, to remove the grease and oil which has collected during the process of manufacture. The accompanying illustrations show a conveyor for this purpose made by the Chain Belt Co., Milwaukee, Wis., which is said to be giving excellent service in a well known factory. It will be seen that the conveyor consists of two strands of what are known as "Griplock" roller chain belt, which is a product of the Chain Belt Co. Between the two strands of chain are attached steel bars with the ends bent up at right angles, and with semicircular recesses punched to suit the diameter of the tubes which have to be handled. These recesses are so formed that the tubes lie slightly on an incline to facilitate draining off the water or pickling fluid as the work leaves the bath.

The upper track is made of steel angle irons which are bent into a series of curves to suit the length and depth of the tank in which the work is to be immersed, and also to suit the length of time during which it is desired to have the work submerged in the different baths. Hold-down guides are provided at the curves and as the chain is fitted with rollers of large diameter, frictional resistance caused by the pull of the chain at the curves is reduced to a minimum. The track is a self-contained unit, constructed in such a way that it can be removed or placed in the tank without disturbing the fittings. The return "run" of the conveyor is over straight angle iron tracks, beneath the tanks. There are four shafts—one main driving shaft and one idler shaft at the delivery end, and one

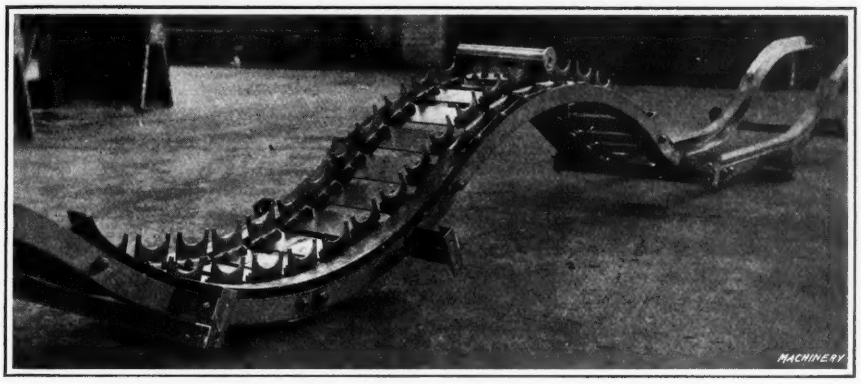


Fig. 1. Chain Belt Conveyor for carrying Shells through Pickling Bath

take-up shaft and one idler shaft at the receiving end of the conveyor. The idler shafts are necessary on account of the depth of the tanks. On each shaft are mounted two cast-iron sprocket wheels, the teeth of which are fitted to the chain links to insure a steady pull and a free movement of the conveyor.

To give an idea of the size in which these conveyors are built, it may be mentioned that the particular installation which is illustrated measures 34 feet from the center of the head shaft to the center of the take-up shaft. This conveyor is motor-driven, the power being transmitted through spur gearing connected to the head shaft; but equally satisfactory results may be obtained by using a belt drive from a lineshaft if conditions make it desirable to employ this type of drive.

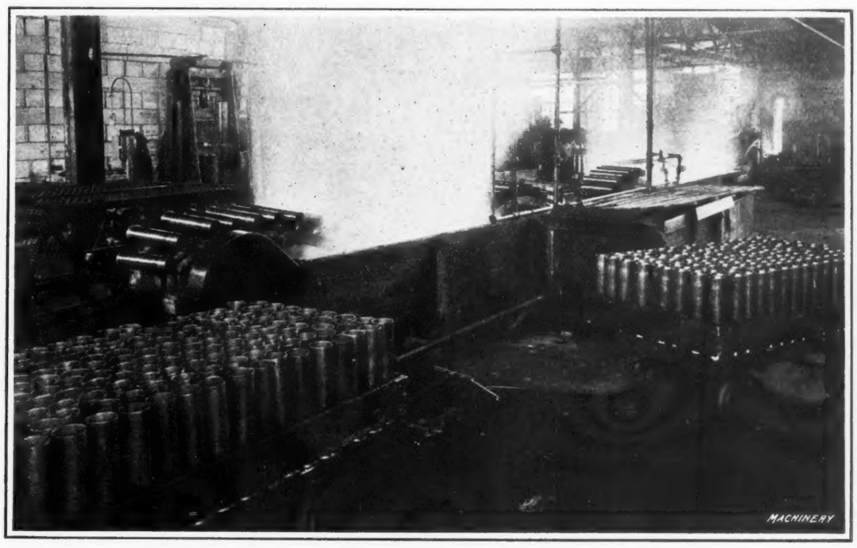


Fig. 2. Chain Belt Conveyor set up in a Pickling Bath

The apparatus is designed in such a way that the tubes to be pickled are loaded onto the conveyor at one end and automatically discharged at the opposite end after they have been passed through the pickling baths and rinsing tanks. The conveyor is capable of passing the tubes through the bath at the rate of 1200 per hour when traveling at a speed of ten feet per minute, but in actual practice the carrying capacity of the conveyor is so utilized that it handles approximately 3000 tubes per hour. The saving effected in the cost of handling tubes by this device is so obvious that the conveyor should readily commend itself to manufacturers of products on which it could be used to advantage.

GIBB "I-RITE" PYROMETER

The chief claim made for the "I-Rite" pyrometer which has recently been placed on the market by the Gibb Instrument Co., Highland Bldg., Pittsburg, Pa., is that it makes a direct measurement of the temperature of the work which is being heat-treated. This is an important point because tests have shown that the temperature of furnaces used for the heat-treatment of metals may vary considerably in different parts of the furnace. For instance, a certain furnace used for annealing sheet metal was found to have a temperature of 900 degrees F. in one place and 1800 degrees F. in another, these extreme temperatures representing the results of a series of twelve readings taken at different points in the furnace. As a further example, reference may be made to a certain installation of furnaces with heating chambers 3 by 2 by 6 feet in size, which are used by a well known automobile manufacturer. The work did not come uniform from these furnaces and to determine the reason, six recording pyrometers were installed at different points in one of the furnaces. The results of the investigation showed that the temperature fluctuated 50 degrees F. from the normal temperature which was required.

Obviously, it is impossible to obtain the best results with work which must be heat-treated at a specified temperature, if the heating is done in a furnace where the temperature varies considerably. But if it is possible to observe the actual temperature of the work so that it is withdrawn when it has reached exactly the required heat, satisfactory results are almost sure to be obtained. This condition is fulfilled with the new Gibb pyrometer; and other claims made for this instrument are its simplicity and convenience, coupled with the fact that it is of such a size that it may readily be slipped into a man's pocket.

The highly satisfactory results in the heat-treatment of steel obtained by the older generation of metallurgists, who depended entirely upon the color method for determining the proper quenching and annealing temperatures, were largely due to the fact that this method depended upon making an estimation of the actual temperature of the metal rather than bringing the furnace to an average temperature corresponding to that required for the process of heat-treatment. The limitation of the color method was that some men using it were unable to carry in mind the exact color corresponding to the temperature they wished to obtain; and the use of pyrometers for measuring temperatures has failed in some cases because the indication of the instrument is accurate

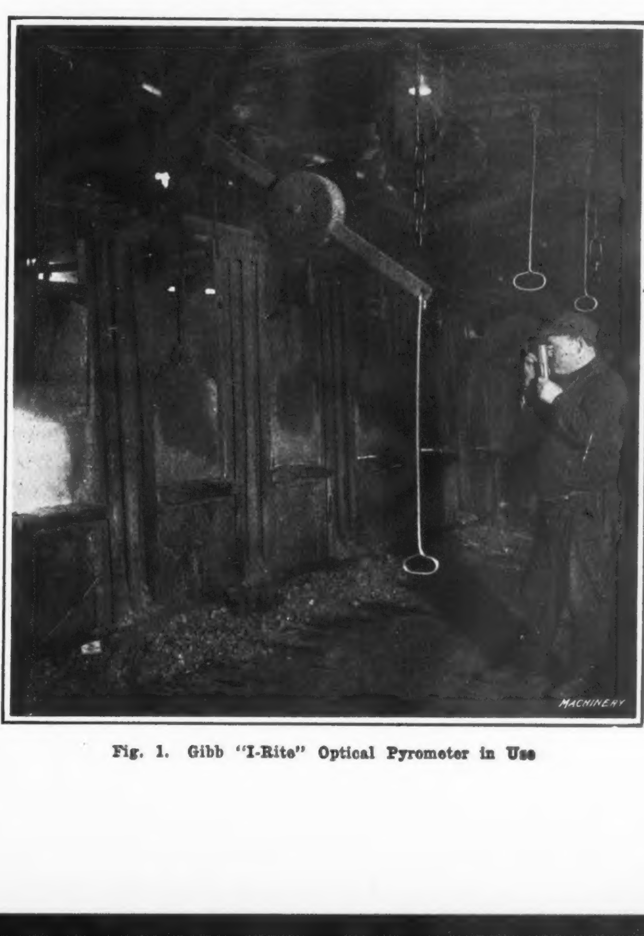


Fig. 1. Gibb "I-Rite" Optical Pyrometer in Use

substantial construction, providing a range of thirty changes of feed by operating two levers on the outside of the box, which can be manipulated while the lathe is running. Means are provided for introducing the usual form of "translating" gears into the drive for cutting threads of any desired metric pitch which come within the range of the lathe. The lathe is driven by a countershaft with double friction clutch pulleys, ample oiling facilities being provided for the countershaft bearings. The regular equipment includes a countershaft, steadyrest, follow-rest, large faceplate, driving belt, screw cutting dial, and the necessary wrenches. When desired, a taper attachment, turret on the carriage, chucks, chuck plates, and any desired forms of turning tools may be furnished as extra parts.

The principal dimensions of both machines are as follows: diameter of hole through spindle, 1¾ inch; diameter of tail-spindle, 2⅛ inches; traverse of tail-spindle, 8½ inches; width of driving belt, 3 inches; range of threads that can be cut, 4 to 40 per inch; range of feeds, 0.010 to 0.110 inch per revolution; length of bed, 6½ feet; maximum distance between centers, 2 feet, 6 inches; swing over bed, 18½ inches; swing over carriage, 12 inches; swing over steadyrest, 11 inches; travel of compound rest, 6½ inches; size of tools used, 1¼ by ⅝ inch; floor space occupied by lathe with six-foot bed, 6 feet, 6 inches by 18½ inches; and weight of machine with six-foot bed, 2600 pounds.

PAWLING & HARNISCHFEGER CENTERING MACHINE

For centering shafts and other cylindrical work, the Pawling & Harnischfeger Co., Milwaukee, Wis., has placed on the market the duplex centering machine illustrated and described herewith. That the machine has a capacity for handling a wide range of work is well brought out by these illustrations. Figs. 1 and 2 show front and rear views of the machine working on a shaft 7¼ inches in diameter by 9 feet, 8 inches long, and Fig. 3 shows a partial rear view of the machine centering a shaft which is only 1⅛ inch in diameter by 30 inches long. This shows in a forcible manner the range of work for which the machine is adapted, although it does not represent the extreme range, as shafts varying in size from ⅞ inch in diameter by 10 inches long up to 7½ inches in diameter by 12 feet long can be centered. It will be seen from the rear views that the machine is equipped with individual motor drive, the motor being direct-connected to a driving shaft at the back of the machine. This shaft, in turn, is belted to the geared heads. When so desired, the machine may also be equipped for belt drive.

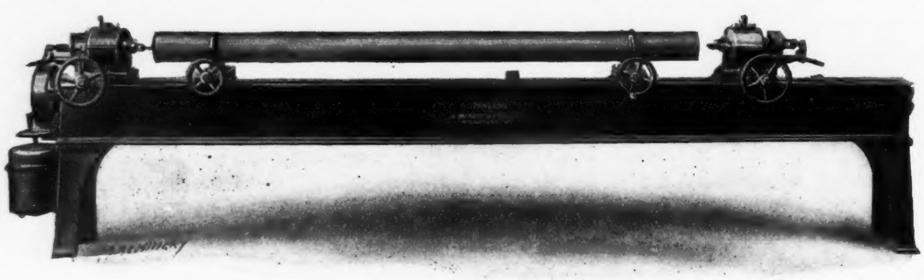


Fig. 1. Front View of Pawling & Harnischfeger Centering Machine working on Shaft 7¼ Inches in Diameter by 9 Feet, 8 Inches Long

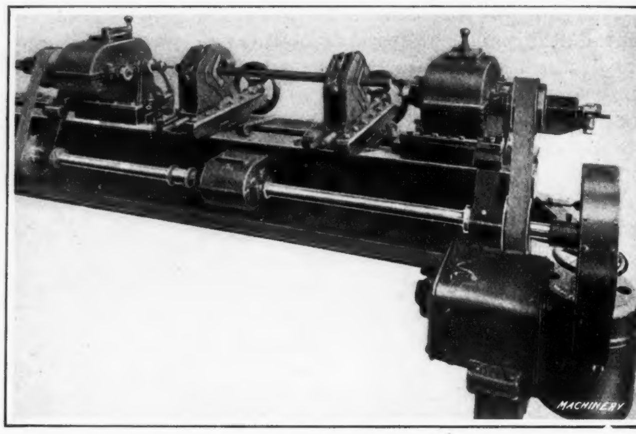


Fig. 3. Close View of Pawling & Harnischfeger Centering Machine working on Shaft 1⅛ Inch in Diameter by 30 Inches Long

The principal dimensions of this Pawling & Harnischfeger centering machine are: length over all, 16 feet, 6 inches; spindle bore, No. 2 Morse taper; drill spindle speed, 600 R. P. M.; reamer speed, 240 R. P. M.; speed of driving shaft, 400 R. P. M.; size of driving pulley for belt drive, 8 inches in diameter by 2¼ inches face width; capacity of motor used for individual motor drive, ½ horsepower; and weight of motor-driven machine, 2200 pounds. The regular equipment of the machine includes two drill chucks for ⅛-inch drills, two three-lipped center reamers 1 inch in diameter, and one supporting jack.

Fig. 2. Opposite Side of Pawling & Harnischfeger Centering Machine shown in Fig. 1

CHAIN BELT PICKLING CONVEYOR

For some time the manufacturers of tubular brass goods and other metal products have felt the need of some form of mechanical conveyor for carrying the work through a series of pickling and rinsing baths, to remove the grease and oil which has collected during the process of manufacture. The accompanying illustrations show a conveyor for this purpose made by the Chain Belt Co., Milwaukee, Wis., which is said to be giving excellent service in a well known factory. It will be seen that the conveyor consists of two strands of what are known as "Griplock" roller chain belt, which is a product of the Chain Belt Co. Between the two strands of chain are attached steel bars with the ends bent up at right angles, and with semicircular recesses punched to suit the diameter of the tubes which have to be handled. These recesses are so formed that the tubes lie slightly on an incline to facilitate draining off the water or pickling fluid as the work leaves the bath.

The upper track is made of steel angle irons which are bent into a series of curves to suit the length and depth of the tank in which the work is to be immersed, and also to suit the length of time during which it is desired to have the work submerged in the different baths. Hold-down guides are provided at the curves and as the chain is fitted with rollers of large diameter, frictional resistance caused by the pull of the chain at the curves is reduced to a minimum. The track is a self-contained unit, constructed in such a way that it can be removed or placed in the tank without disturbing the fittings. The return "run" of the conveyor is over straight angle iron tracks, beneath the tanks. There are four shafts—one main driving shaft and one idler shaft at the delivery end, and one

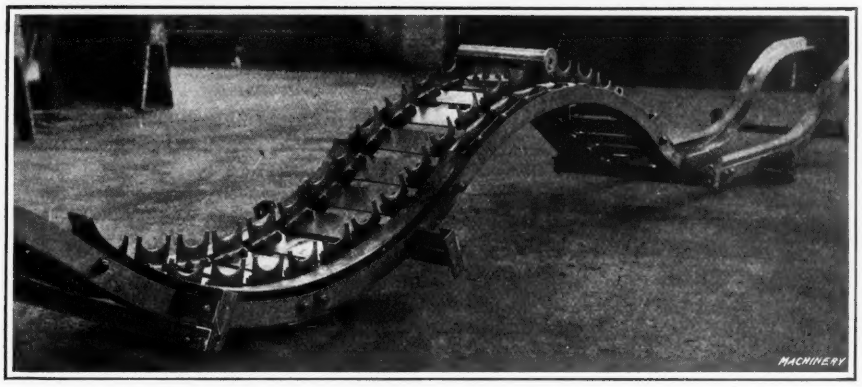


Fig. 1. Chain Belt Conveyor for carrying Shells through Pickling Bath

take-up shaft and one idler shaft at the receiving end of the conveyor. The idler shafts are necessary on account of the depth of the tanks. On each shaft are mounted two cast-iron sprocket wheels, the teeth of which are fitted to the chain links to insure a steady pull and a free movement of the conveyor.

To give an idea of the size in which these conveyors are built, it may be mentioned that the particular installation which is illustrated measures 34 feet from the center of the head shaft to the center of the take-up shaft. This conveyor is motor-driven, the power being transmitted through spur gearing connected to the head shaft; but equally satisfactory results may be obtained by using a belt drive from a lineshaft if conditions make it desirable to employ this type of drive. The apparatus is designed in such a way that the tubes to be pickled are loaded onto the conveyor at one end and automatically discharged at the opposite end after they have been passed through the pickling baths and rinsing tanks. The conveyor is capable of passing the tubes through the bath at the rate of 1200 per hour when traveling at a speed of ten feet per minute, but in actual practice the carrying capacity of the conveyor is so utilized that it handles approximately 3000 tubes per hour. The saving effected in the cost of handling tubes by this device is so obvious that the conveyor should readily commend itself to manufacturers of products on which it could be used to advantage.

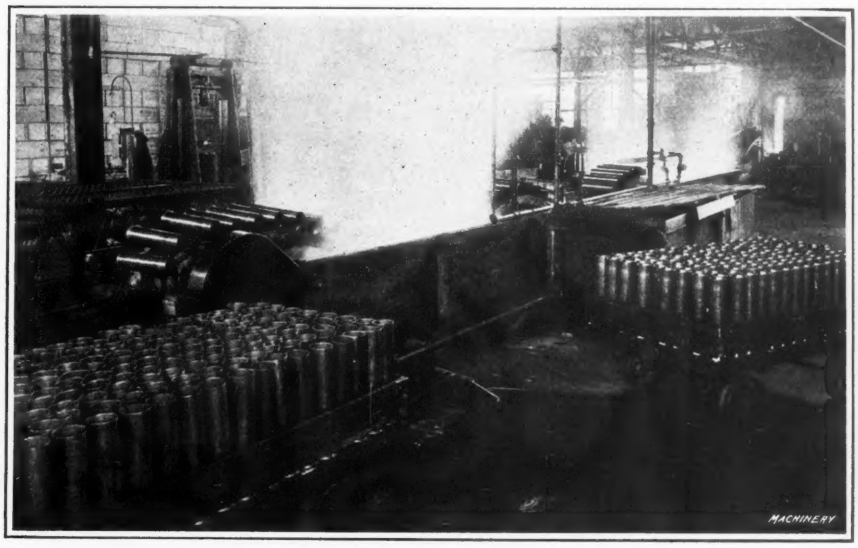


Fig. 2. Chain Belt Conveyor set up in a Pickling Bath

GIBB "I-RITE" PYROMETER

The chief claim made for the "I-Rite" pyrometer which has recently been placed on the market by the Gibb Instrument Co., Highland Bldg., Pittsburg, Pa., is that it makes a direct measurement of the temperature of the work which is being heat-treated. This is an important point because tests have shown that the temperature of furnaces used for the heat-treatment of metals may vary considerably in different parts of the furnace. For instance, a certain furnace used for annealing sheet metal was found to have a temperature of 900 degrees F. in one place and 1800 degrees F. in another, these extreme temperatures representing the results of a series of twelve readings taken at different points in the furnace. As a further example, reference may be made to a certain installation of furnaces with heating chambers 3 by 2 by 6 feet in size, which are used by a well known automobile manufacturer. The work did not come uniform from these furnaces and to determine the reason, six recording pyrometers were installed at different points in one of the furnaces. The results of the investigation showed that the temperature fluctuated 50 degrees F. from the normal temperature which was required.

Obviously, it is impossible to obtain the best results with work which must be heat-treated at a specified temperature, if the heating is done in a furnace where the temperature varies considerably. But if it is possible to observe the actual temperature of the work so that it is withdrawn when it has reached exactly the required heat, satisfactory results are almost sure to be obtained. This condition is fulfilled with the new Gibb pyrometer; and other claims made for this instrument are its simplicity and convenience, coupled with the fact that it is of such a size that it may readily be slipped into a man's pocket.

The highly satisfactory results in the heat-treatment of steel obtained by the older generation of metallurgists, who depended entirely upon the color method for determining the proper quenching and annealing temperatures, were largely due to the fact that this method depended upon making an estimation of the actual temperature of the metal rather than bringing the furnace to an average temperature corresponding to that required for the process of heat-treatment. The limitation of the color method was that some men using it were unable to carry in mind the exact color corresponding to the temperature they wished to obtain; and the use of pyrometers for measuring temperatures has failed in some cases because the indication of the instrument is accurate

Fig. 1. Gibb "I-Rite" Optical Pyrometer in Use

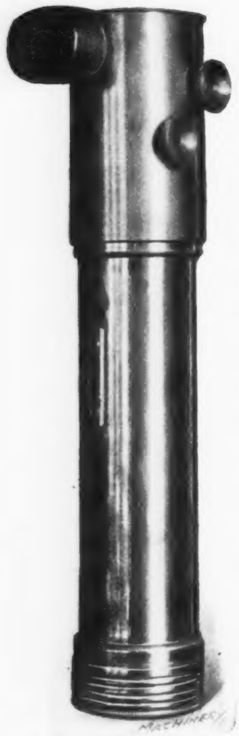


Fig. 2. Gibb "I-Rite" Optical Pyrometer

for a particular point in the furnace, but does not indicate that the temperature of the furnace is uniform throughout. With the Gibb "I-Rite" pyrometer, a scale is provided which exactly duplicates the color of heated bodies at different temperatures and it is claimed that the instrument makes it possible to read the temperature of the work within a limit of accuracy of two per cent, regardless of the temperature of the furnace. The use of the pyrometer enables the metallurgist to ascertain instantly whether or not the piece is at the required temperature for quenching or annealing.

As the use of this instrument depends upon the sensitiveness of the eye and its ability to distinguish shades of color, the following results of an experiment conducted by Prof. E. L. Nichols of Cornell University are of interest. He placed ninety-two shades of blue before fifty-four observers and the general average of efficiency in placing these shades in the proper relation to each other was over 95 per cent. An interesting fact in connection with this sensitiveness of the eye is that a man who is color blind can still read the Gibb pyrometer with the same accuracy as one who distinguishes colors properly, because although the color may not appear of the proper shade, he is still able to compare it with a standard of the desired color and intensity.

The operation of the Gibb "I-Rite" pyrometer is said to be so simple that it may be used with almost equal facility by an unskilled workman or by an experienced metallurgist; and the construction is so simple that the instrument is not likely to get out of order. The instrument is primarily intended for the precise measurements of temperatures of steel during the process of heat-treatment, and is made in two sizes with capacities for measuring temperatures from 1000 to 1800 degrees F., and from 1800 to 2300 degrees F., respectively. It is suitable for use in determining the temperature of heated metal, either before or after its removal from the furnace; consequently, it is possible to use the instrument for obtaining temperatures of heated steel in the form of ingots, billets, rails, armor plates, forgings, or castings.

WRIGHT CHAIN HOIST

Wright Chain Hoist

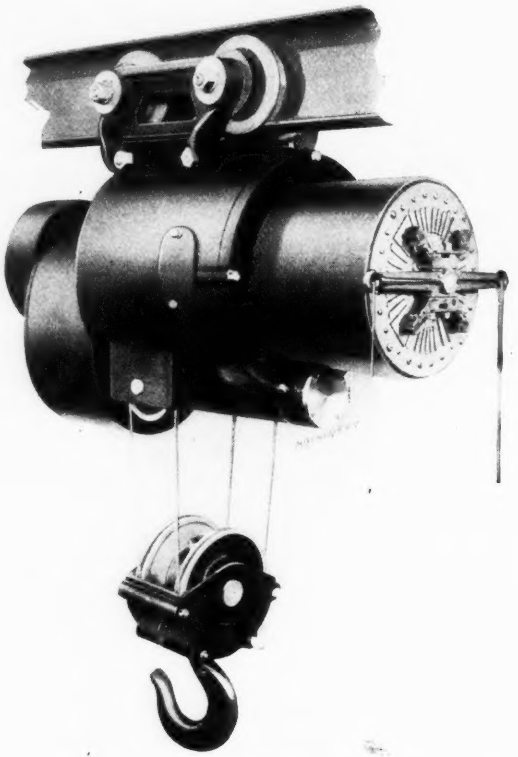
One of the latest additions to the line of hoists made by the Wright Mfg. Co., Lisbon, Ohio, is the chain hoist illustrated and described herewith. It is furnished with a system of planetary gearing which gives a mechanical efficiency of 80 per cent; and the use of steel or malleable iron for the construction of every working and load-supporting part makes the hoist capable of handling exceptionally heavy loads. These features of construction also give long life to the hoist and practically eliminate the breakage of parts.

The non-fouling hand-chain guide provided permits of raising or lowering the load by a chain pull from any direction, and all tendency for the chain to jerk or catch is said to be positively eliminated. With a one-ton hoist of this type a man can lift the full load by overhauling 30 feet of hand chain with a pull of 82 pounds; and with the two-ton hoist it requires 120 pounds pull with an overhaul of 120 feet of chain to lift the load.

ECONOMY ELECTRIC HOIST

In designing the electric hoist which forms the subject of this description, the Economy Engineering Co., Willoughby, Ohio, has paid particular attention to the development of a mechanism combining the features of simplicity and compactness, with all parts readily accessible. By removing steel cover plates, the commutator brushes are exposed for inspection or adjustment, and taking off the end frame renders all parts accessible. The construction is such that any unit may be removed without disturbing other parts, which is a feature that greatly facilitates the making of repairs. The mechanism is completely enclosed, making the hoist adaptable for outside service or in places where trouble would otherwise be experienced from dust and acid fumes. No additional covering is required.

The hoisting unit lends itself readily to any one of several mountings. The one shown in the illustration, using a plain trolley to run on the lower flange of an I-beam rail, is traversed by simply pushing against the load. This is the type recommended for hoists up to two tons capacity. The same trolley can be fitted with a hand chain for racking, or with motor drive for use on high-speed installations or on long runs and on hoists which have an operator's cab attached to them. The hoist can be furnished mounted at right angles to the position shown, or with hook suspension; and it may be mounted in many special ways to suit unusual conditions. The hoist and cables are so arranged that the hoist is always in perfect balance regardless of the type of suspension or the magnitude of the load being handled.



Electric Hoist manufactured by Economy Engineering Co.

The hoist frame is made of cast iron, cylindrical in form and so constructed that the operating mechanism is rigidly supported. The drum is centrally located within the frame, and only a small opening is required for the rope to pass through; consequently, very little of the drum is exposed. The portion of the frame containing the gearing and mechanical brake is separated from the drum and motor in such a way that the gears may be packed with grease. The hoist is equipped with standard Hyatt roller bearings which reduce power consumption and increase the life of the hoist. On account of the comparatively slow movement, the drum bearings are bushed with bronze. Spur gearing is used throughout, the gears and pinions being cut from steel blanks which are heat-treated to bring out the most desirable physical characteris-

tics of the metal. The bearings are provided with ample facilities for lubrication. The drum is made of cast iron and is grooved to receive the full amount of rope without overlapping. Special attention is called to the fact that the drum replaces the motor frame and revolves around the motor armature, which represents a departure from established practice in hoist design. This form of construction enables the drum to be made of an unusually large diameter without increasing the size of the hoist.

The hoist cable is made of plow steel, and the load block consists of a cast frame containing sheaves of large diameter, which are fitted with roller bearings. The hoist is equipped with a mechanical load brake which automatically stops and holds the load when the motor is stopped; and this brake can only be released by revolving the motor in the lowering direction. The brake is of the friction disk type and has no intricate parts which are likely to be broken. The solenoid brake is capable of holding the full load of the hoist and will instantly stop the motor when the current is shut off. Motors can be provided for use on either alternating or direct current; and either a rheostat or single-speed control can be furnished, according to the requirements of the shop in which the hoist is being used. The rheostat control is used where delicacy or accuracy in the handling of the load is required, as in the case of foundries where sand molds are to be lifted by the hoist; and the sole function of the single-speed control is to start and stop the motor. All hoists are equipped with an automatic limit switch which is operated by the block when it has reached its highest position, and instantly stops the hoisting motor. These hoists are made in sizes that have lifting capacities ranging from 1000 to 10,000 pounds.

DOW MILLING MACHINE

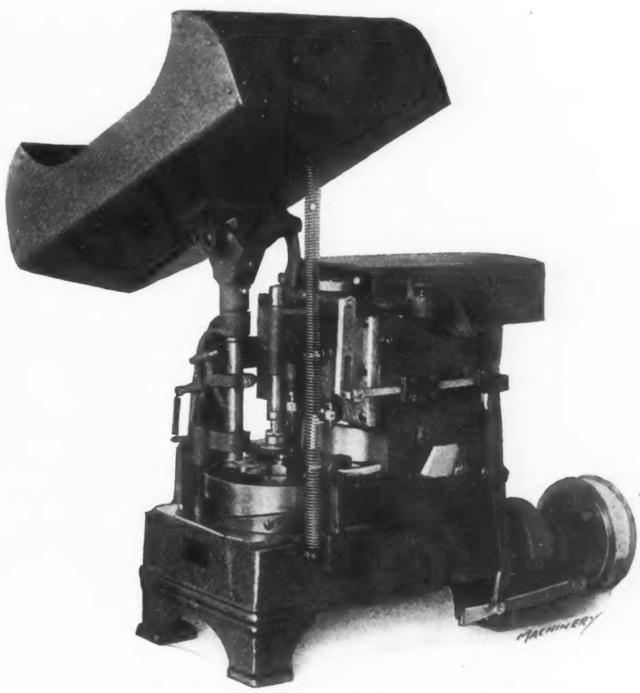
The Dow Mfg. Co., Braintree, Mass., has placed on the market the plain milling machine shown in the accompanying illustration. This machine is designated as the No. 1 size and is intended for general manufacturing milling operations—in fact, for any plain milling within its range. While no radical features are incorporated in the design of the machine, it has been the aim of the manufacturers to produce a very rugged manufacturing miller that will produce accurate work. The drive of the machine is to a four-step cone pulley on the spindle, and through back-gearing eight spindle speeds may be obtained.

The table of the machine is supported on a knee with long bearings on the column. The table is 37 inches long by 8 inches wide; and it may be fed 21 inches longitudinally, and 8 inches in a cross direction. The knee of the machine has a vertical travel of 16 inches on the column. While the table is only provided with power feed in a longitudinal direction, the cross and vertical feeds can be equipped for power drive, if so desired. The feed motion for the table is taken from the spindle and transmitted to the gear-box by a silent chain. The gear-box is oil-tight, and there are three available rates of feed for each spindle speed. The spindle and many other shafts in the machine are made of tool steel, which is hardened and ground. The arbor is supported with the usual type of overhanging arm, and will accommodate cutters eight inches long. Weight of machine is 2200 pounds.

No. 1 Plain Milling Machine built by Dow Mfg. Co.

SLOAN & CHACE CARTRIDGE VENT DRILLING MACHINE

For use in drilling two vent holes through the cap cavity of a cartridge butt, the Sloan & Chace Mfg. Co., Ltd., 6th Ave. and North 13th St., Newark, N. J., has recently brought out the machine shown in the accompanying illustration. The cartridges to be drilled are thrown into an oscillating hopper which automatically selects and drops one cartridge at a time into the feed-tube. This tube is provided with a mechanism which drops one cartridge each time the chuck turret comes to rest with an open chuck in place under the feed-tube. This chuck turret carries the cartridge successively under two drills and then under a two-pin gage which moves intermittently with the drills; and if through the breaking of a drill or for any other cause, the two holes have not been properly drilled, the gage mechanism releases a clutch and stops the machine. After passing the gage, the chuck is automatically opened and the drilled cartridge drops through an opening in the bench into the receptacle placed to catch it. The chuck remains open until another blank drops from the feed-tube, and then automatically closes while moving toward the drills.



Cartridge Vent Drilling Machine built by Sloan & Chace Mfg. Co.

The drill spindles are made of steel which is hardened and ground, and they run in steel bushings which are also hardened and ground to size. The speed of the spindles is 11,220 revolutions per minute. It has been mentioned that the gage is connected with a friction clutch which automatically stops the machine if a cartridge has not been drilled through. The gage points are mounted in a disk which is adjustably held by a screw cap, and the gage points are set while the disk is free by inserting them into the first cartridge which is drilled; the gage is then locked in that position by tightening the screw cap. New gage points may be mounted on the machine by removing the holding cap and inserting a new disk, the points being re-set by the method which has just been described. The clutch is of the expanding friction-ring type, and is adjustable. The principal dimensions are as follows: height, 22 inches; length, 22 inches; width, 18 inches; and weight of machine with feed hopper and countershaft, 178 pounds. The machine has a capacity for drilling 1100 cartridges per hour.

PAWLING & HARNISCHFEGER DRILL PRESS

To meet the requirements of the heaviest classes of drilling, the Pawling & Harnischfeger Co., Milwaukee, Wis., has recently placed on the market an upright drill press which is illustrated and described herewith. The drive is transmitted through positive jaw clutches and hardened steel sliding gears

which provide nine changes of spindle speed. All bearings in the speed mechanism are furnished with Hess-Bright annular ball bearings of ample size, which insure positive alignment, durability and high efficiency. Any of the nine available spindle speeds may be instantly obtained. All speed and change gears are housed in a single gear-box and are controlled by three levers which govern the entire range of speed and feed changes, the changes of feed being obtained by a single lever. All the gears in the speed and feed trains are made of special steel which is heat-treated.

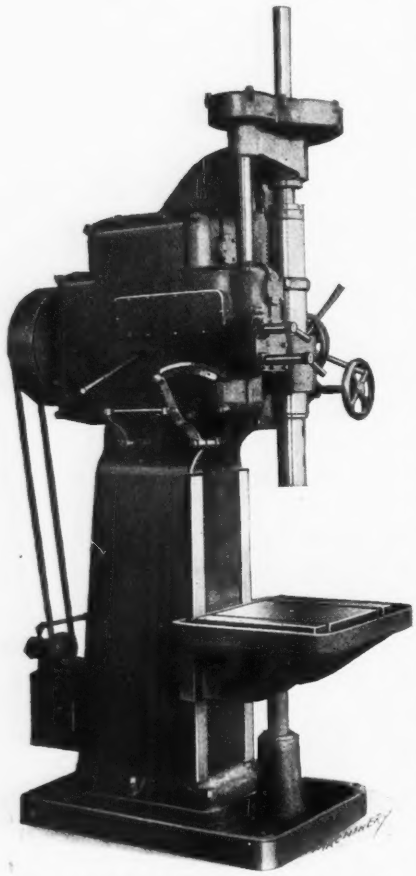


Fig. 1. Pawling & Harnischfeger Heavy-duty Upright Drill

The spindle is made from a high-carbon steel forging and is supported by bronze bushed radial bearings and a ball thrust bearing. The end of the spindle is slotted for driving boring and facing attachments, and is bored No. 6 Morse taper. An automatic depth stop is provided for disengaging the feed at a predetermined point. The spindle sleeve is of large size and is equipped with bronze bearings for the spindle. The feed rack is made of steel and set into the sleeve in such a way that ample support is provided for the end thrust. The feed pinion is cut solid on the shaft, and the worm and worm-wheel which drive this shaft are made of hardened steel and of a special grade of semi-steel, respectively, with the teeth accurately cut to insure long life and smooth operation. Capstan bars are provided on the worm-wheel hub to permit of a quick return of the counterweighted spindle. Six changes of feed are available for each of the nine spindle speeds.

The table is of the box type and provided with two T-slots of standard size; it is raised and lowered by a telescopic screw which is constructed in a way that makes it unnecessary to provide clearance below the floor level. A 2½-inch hole is bored in the table to provide outboard support for boring-bars which may be used on this drill press; and a lubricant pump is furnished as part of the regular equipment of the machine. It has been stated that the drill is driven by positive clutches, and the shifter lever is located within easy reach of the operator. Either straight or right-angle drive may be furnished to suit the requirements of the shop in which the machine is to be used. All such parts as gears, worms, etc., are carefully covered with guards to provide for the safety of the operator.

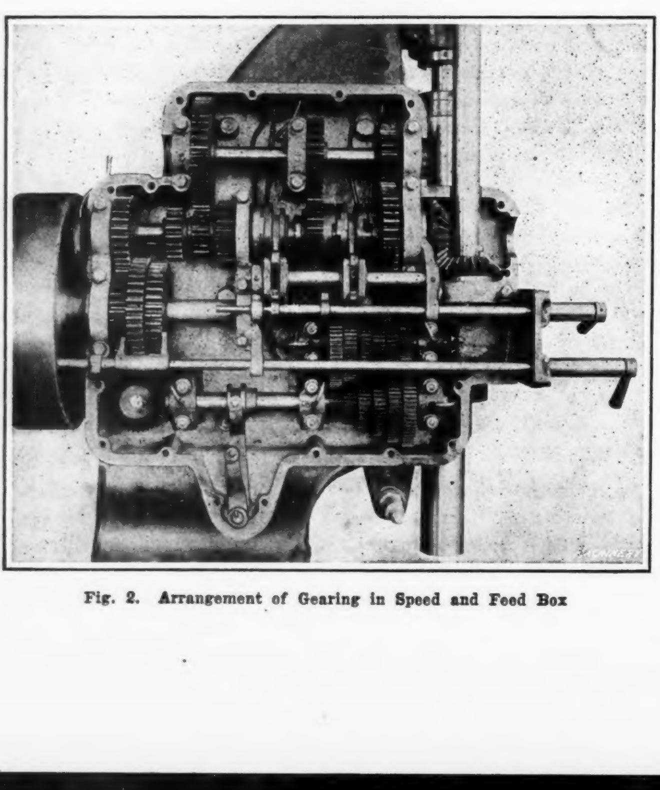


Fig. 2. Arrangement of Gearing in Speed and Feed Box

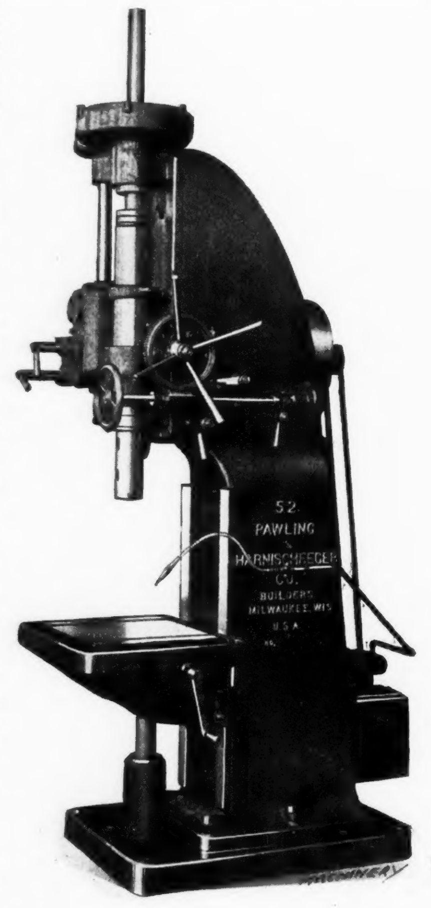


Fig. 3. Opposite Side of Machine shown in Fig. 1

The principal dimensions of the machine are as follows: capacity for drilling holes in steel, up to 2½ inches in diameter; distance from center of spindle to face of column, 12 inches; maximum distance from end of spindle to table, 32 inches; spindle travel, 16 inches; diameter of spindle sleeve, 5½ inches; bore of spindle, No. 6 Morse taper; size of table, 19 by 23 inches; vertical adjustment of table, 20 inches; available feeds, 0.007, 0.010, 0.016, 0.028, 0.042, and 0.064 inch per revolution; available spindle speeds, 41, 54, 72, 95, 124, 167, 227, 300 and 400 revolutions per minute; floor space occupied by the machine, 4 feet by 3 feet, 6 inches; and weight, 4900 pounds.

NEW MACHINERY AND TOOLS NOTES

Friction Surface Facing: Royal Equipment Co., Bridgeport, Conn. A friction facing material known as "Raybestos" which is adapted for use on friction clutches, hoisting drums, brake rings, and similar forms of mechanism.

Flexible Steel Belt Lacing: Manufacturers Belt Hook Co., Chicago, Ill. A flexible steel belt lacing with a ball bearing joint, which is noiseless in operation and easily attached. The chief claim made for the lacing is that it makes very strong belt joints.

Horizontal Hydraulic Press: Metalwood Mfg. Co., Detroit, Mich. A press designed to meet the requirements of shops which have use for a press capable of developing high pressure, but where speed of operation and a high rate of output are not essential.

Adjustable Sizing Tap: Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich. An adjustable sizing tap which is made in various sizes and styles of thread. This tap is of the same form as the tap of the combination threading die and tap which was described in the March number of MACHINERY.

Portable Pneumatic Drill: Ingersoll-Rand Co., 11 Broadway, New York City. A compound geared type of pneumatic drill which is suitable for use in flue rolling, drilling, reaming and tapping. The reversible feature of the drill makes it applicable for use in running on flexible staybolt sleeves or for setting locomotive valves.

Heavy-duty Lathe: W. & B. Douglas, Middletown, Conn. A single-purpose machine designed for turning and boring shells, and for similar classes of general manufacturing work. All

parts of the machine are heavily built to stand up under severe conditions of service. Three changes of speed and four variations of feed are available.

Straightening Machine: Brightman Mfg. Co., Columbus, Ohio. A machine for straightening round bars ranging in size from 1 to 2½ inches in diameter. The machine is known as a ten-roll straightener, and in addition to straightening the bars it imparts a high finish. The capacity is for straightening from 20 to 40 feet of bars per minute.

Universal Controller: Allen-Bradley Co., Milwaukee, Wis. A line of controllers for use on rope-operated hoists where the service is intermittent. The controller is said to be universal in its application because it can be used with either direct- or alternating-current motors. The construction is such that the controller can be installed in practically any convenient position.

Scrap Baling Machine: Standard Pressed Steel Co. of Ohio, Cleveland, Ohio. A baling press for compressing iron and steel scrap, which has a capacity for handling material up to No. 10 gage; and scrap up to No. 6 gage may be handled if it is soft and pliable. The press is of simple construction and the charging box in which the material is deposited is 42 inches long by 16 inches wide by 22 inches deep.

Engine Lathe: Davenport Locomotive Co., Davenport, Iowa. A single back-geared heavy-duty lathe adapted for shell work and general lines of manufacture. The design follows established practice in the construction of machines of this type. The noteworthy features are an exceptionally heavy construction combined with simplicity of design, so that unskilled labor may quickly be taught to run the lathe.

Vacuum Pump: Ingersoll-Rand Co., 11 Broadway, New York City. A horizontal, center-crank vacuum pump intended for use in connection with condensers and for other service where it is necessary to maintain a high vacuum. The pump has been developed from this company's straight-line air compressor and is intended for either steam or belt drive. The capacity is from 292 to 2295 cubic feet per minute.

Crane and Hoist Controller: Cutler-Hammer Mfg. Co., Milwaukee, Wis. A reversible type controller designed for overhead mounting with rope operation. This controller is intended for use indoors and for duty in regulating intermittent speed, such service being found on cranes and hoists. It is made in two standard types, one of which gives 50 per cent speed reduction and the other 90 per cent reduction.

Cylinder Boring-bar: E. J. Rooksby & Co., Philadelphia, Pa. A portable locomotive-cylinder boring-bar intended for use in reboring cylinders and valve chamber bushings. The tool can be used with one or both cylinder heads removed, being provided with crosshead blocks which are bolted to the cylinder with the cylinder head studs. The boring-bar revolves in sleeves which are supported and centered by set-screws in the crossheads.

Hydraulic Arbor Press: Lourie Mfg. Co., Springfield, Ill. A hydraulic press on which the movement of the ram is unusually rapid, eight strokes of the pump handle serving to raise the ram 6 inches. When heavy pressure is reached, the large piston of the pump differential is automatically disengaged, heavy pressures up to 30 tons being produced by the small piston which moves the ram at a rate of 1 inch for seven strokes of the pump handle.

Vertical Air Compressor: Lyons Atlas Co., Indianapolis, Ind. A portable self-contained two-stage vertical air compressor driven by an internal combustion engine. This compressor is built in capacities for delivering from 35 to 150 cubic feet of air per minute at a maximum pressure of 200 pounds per square inch. Reference has been made to the fact that the compressor is portable, but it may also be removed from the truck and employed for stationary service.

Multiple-spindle Drilling Machine: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. A multiple-spindle drilling machine equipped with what is known as a "center feed," with which the feed pressure is applied at the center of the head in the middle of the drill layout, so that any tendency of the head to spring away from the guides is eliminated. Other features of this machine are essentially the same as those of the well-known multiple drill presses manufactured by this company.

Electric Shop Tractor: Mercury Mfg. Co., Chicago, Ill. A tractor for use in pulling about factory trucks on which the product is loaded for transfer from one department to another. The provision of an independent power unit enables the tractor to be constantly in use, while the trucks may be loaded at the convenience of the different departments. The tractor is driven by an electric storage battery which supplies power to a Westinghouse electric motor from which it is transmitted direct to the rear axle through a worm-gear.

Worm Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine represents the further development of a machine of the same type which was developed about fifteen years ago for use in the factory of the Newton Machine Tool Works. In its present form it embodies a number of improved features of design and is offered to the trade for the first time. The work consists of hollow cylinders which have previously been turned to the proper outside diameter; they are mounted on a mandrel which is supported at one end by a collet in the machine spindle.

Manufacturing Lathe: Robert H. Snider & Co., 1524 Chestnut St., Philadelphia, Pa. An 18-inch lathe adapted for general manufacturing work, and particularly for use in factories engaged in the manufacture of shrapnel and high-explosive shells. As the lathe is intended for manufacturing work, only eight spindle speeds are provided, four of which are secured by a selective sliding-gear headstock, the other four being obtained by the use of a two-speed countershaft. The general design follows that of standard heavy manufacturing lathes with the parts liberally proportioned to withstand the test of severe service.

Turret Head: Charles Eisler, 43 Dodd St., Bloomfield, N. J. A turret head for use on lathes in shops where the amount of screw machine work is not sufficient to warrant the installation of a standard screw machine. The turret is of extremely simple design and can be put in the working position as quickly as an ordinary lathe center or chuck. The head does not rotate, as is usually the case with lathe turrets, but swings to reach the various settings of the tools, which are three in number. It is claimed by the maker of this head that more than 85 per cent of the work requiring the use of a turret machine can be handled satisfactorily with a series of three tools.

* * *

HELP WANTED ADVERTISEMENTS EXTRAORDINARY

The accompanying reproduction of a portion of an advertising page clipped from the *Bridgeport Evening Post*, indicates how extraordinary is the demand for labor in the Connecticut city now styled by some the "American Essen." It is very seldom that display advertisements are published like these calling for all grades of labor. The need there for machinists, toolmakers, and milling machine and punch press operators is unprecedented. One large concern has been carrying on a systematic canvass for the skilled labor required to operate its enormous plant to full capacity, but it still lacks thousands of the number wanted. The growth of Bridgeport during the past year is unparalleled in its history, and the demand for houses, tenements and boardingplaces is far in excess of the supply.

Help Wanted!

* * *

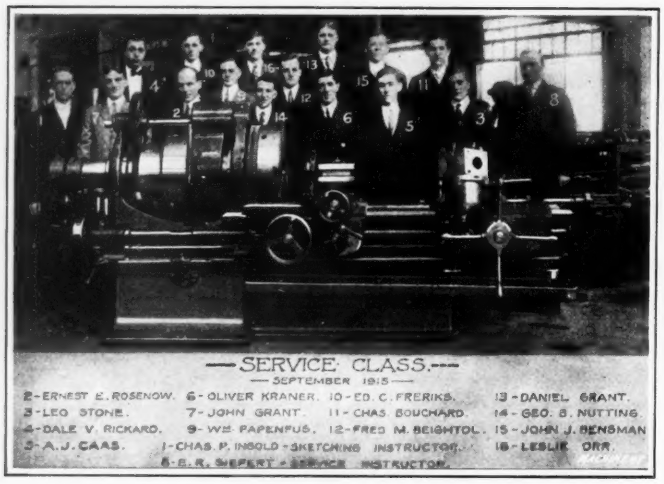
In the practice of interchangeable manufacturing, quick-action machine vises play a prominent part, especially in the production of firearms, typewriters and similar products. The vises provided with false jaws, stops, locating pins, and other means for holding the work in a fixed position are quickly operated and cheaply maintained. In preparing for interchangeable manufacture, it is not necessary to invest large sums in elaborate fixtures, but instead quick-action machine vises may be fitted with jaws suitable for holding all the parts within their range requiring milling operations. In use, the fixtures are washed free from chips by a flood of soda water, so that no trouble is experienced by chips getting under the parts and throwing them out of line. The quick-action vise may be used for a great number of operations, the false jaws are quickly changed, and in themselves represent comparatively small toolmaking cost.

SERVICE COURSE, GISHOLT MACHINE CO.

The Gisholt Machine Co., Madison, Wis., has instituted a service course for the purpose of giving those men who wish to take advantage of the opportunities a chance to progress, and to supply its customers with men who are thoroughly familiar with the construction of the Gisholt turret lathe and proficient in handling it. Following is a statement of the qualifications required and what the service course consists of:

Qualifications

1. To be able to handle all sizes of machines, a man should be at least five feet six inches in height, although men under this height who have all the other qualifications could probably be placed. He should be about twenty years of age, to have had time for proper schooling and the three years practical experience mentioned below. He should not be over thirty-five years of age when starting the course. Otherwise, there will not be time for him to acquire the experience necessary for holding the responsible position which ought to result later, from his taking the service course.



Service Class, Gisholt Machine Co.

2. A man should have had three years or more practical experience in operating machine tools. This is necessary if he is to grasp in the one-year course all the information which he must have in order to do the service work in the field after he leaves us.

3. In order to receive promotion through the several branches of the course, a man must constantly demonstrate that he is capable, diligent and dependable.

The Service Course

The service course consists of:

1. Not more than 1000 hours in general manufacturing departments.

2. Not more than 900 hours in the building of turret lathes. This consists of all the scraping and lining up of beds, slides, bearings, etc., assembling of headstocks, feed-boxes, turret and toolpost carriage slides complete, aprons for both turret slide and toolpost carriage slide, rapid traverse, etc.

3. Not more than 900 hours operating in the turret lathe department.

4. Not more than 200 hours in the service department at which time instructions will be given regarding the handling of the work in the field. Catalogues, data for reference, etc., will be given out at this time.

The length of the course is at a maximum approximately one year.

Disposition of Service Course Men

We intend that each man shall have the chance to acquire such a knowledge of our product that we will be proud to recommend him to our customers at any time.

When the course is completed, we will secure for each man a position on the pay-roll of one of our customers in which he will receive at least the same hourly rate as paid him by us during the course.

The nature of the position will be governed by the qualifications of the man for whom it is secured. It may be one of operating, repairing, tool setting or foremanship.

When the man leaves for his new position in our customer's plant, we will pay his railroad fare from Madison to the city in which that plant is located. In special cases where we agree to do so when a man starts the course, we will also refund the railroad fare which he paid to reach Madison.

Basis of Service Course

1. The man will receive during the entire course the hourly rate of wages which is agreed upon at the beginning. He must agree to this and must also agree that he will accept, at not less than the same rate, the position to be secured for him by the Gisholt Machine Co.

2. That during unsettled business conditions, the service course men will be kept on the pay-roll up to such time as it is necessary for the company to reduce its force to a minimum. This minimum would consist of only those who had been what we call our regular men.

3. In the interests of all concerned, the company reserves the right to make such changes in the above plan as may seem expedient.

* * *

DURABILITY OF HIGH-SPEED DRILLS

The question regarding the amount of work that a high-speed drill one-inch diameter will do between grindings when running at a speed of 400 revolutions per minute and with a feed of three inches per minute in forty-point carbon steel, was submitted to George E. Hallenbeck, superintendent of Baker Bros., Toledo, Ohio, who gave his opinion substantially as follows:

A one-inch drill running at 400 R. P. M. with a feed of three inches per minute would have a peripheral speed of approximately 105 feet, and the feed per revolution would be 0.0075 inch. At this speed and feed a drill provided with a copious supply of cooling lubricant, drilling material not exceeding two inches thick, should, on an average, drill from 300 to 500 inches between grindings. The depth of the hole drilled has a very marked influence on the durability of the drill. The deeper the hole, the more often it will be necessary to grind the drill. The depth of the hole affects the grindings not in a direct but in a higher ratio. This is due to several factors, one of which is the failure of the lubricant to reach the drill point as freely as it should; another is that hot chips lie against the drill and heat the entire body, preventing it from carrying away the heat from the point. The chips also clog and score the lands of the drill in deep holes and cause a considerable increase in heating. These are probably the most important factors. Another factor which enters into the question of the time between grindings is the manner in which the drill is ground, the clearance angle given the drill and the lipping of the drill. We have found that a clearance angle about two degrees greater than that ordinarily given by the drill makers will cause the drill to cut freer and materially increase the depth that can be drilled between grindings.

Whether the steel is clear open-hearth or Bessemer and whether it is forged or rolled stock also affects the durability of the drill. Probably the most important item of all is the manganese content. Steels that are high in manganese have a tendency to wear away the cutting edge of a drill rapidly, and if they are carelessly handled in the rolling or forging, segregated manganese and chilling are likely to occur. Segregated manganese in steel will ruin a drill the moment it strikes it and the chilling imposes considerable work on the drill. Altogether there are so many factors influencing the durability of drills that it seems practically impossible to lay down any definite rule to apply generally.

* * *

NO N. M. T. B. A. SPRING CONVENTION

The executive committee of the National Machine Tool Builders Association has decided, in view of the great stress of business, not to hold the usual spring convention, with regular program, this year.

* * *

A man who was sent by an independent set of employers to investigate the Lawrence strike told me that he found much more intelligence among the labor leaders than among the employers concerned, and that they had a far clearer comprehension of the problems involved. His mission in the investigation was to report to those who engaged him as to the best method of combating the I. W. W. They got the answer that nothing permanent could be done until the employers learned more about the industrial problems with which they had to deal.—*H. L. Gantt, in Industrial Leadership.*

FOREIGN TRADE POLICIES

SOME OF THE EFFECTS OF THE WAR ON TRADE AND POSSIBLE FUTURE DEVELOPMENTS

IN his annual report, President Meyer of the Association of German Iron and Steel Manufactures said that Germany's ability to carry on the war is due to the development of the nation's resources by her enormous foreign trade. Reginald McKenna, chancellor of the exchequer, said last month that one of the chief factors in Great Britain's power of endurance is her commercial interests; that if her trade is destroyed her life as well as her ability to help her allies and her dominions is destroyed. Frank A. Vanderlip, president of the National City Bank of New York, said that expansion of foreign trade is absolutely necessary if the United States is to maintain its credit at the end of the war; that as long as the war continues gold will flow into the country, but just as soon as the war is over every nation will attack the nation's gold reserve by every method known to trade and commerce, and that if this attack is successful the entire United States credit will have to be adjusted, for the reduction in credit will be many times greater than the loss in gold. While this attack can be resisted by the investment in short-term foreign loans, the only effective means of resistance is the development of foreign trade.

Many bankers think that this attack was begun last month when so large a quantity of German securities was sold in New York, for as soon as the ocean is again free to German vessels the large bank balance that Germany has in New York may be drawn out in gold. To retard as far as possible the growth of the American gold reserves, England has stopped buying wheat in the United States, though it recently purchased $86,000,000 worth of the cereal in Australia, Argentina, and Rumania.

That the entire world is seeking American goods is shown by the inquiries and orders sent here daily. A representative of an American machinery firm recently refused an order, amounting to nearly $1,250,000, from a Russian dealer because the dealer wanted to withhold payment until one year after the end of the war; a leading Russian banker was willing to guarantee the payment of both the principal and the interest. It is doubtful if the manufacturers of any nation, even Germany, will extend to the purchaser the extremely long credits that were so great a factor in the building up of the German foreign trade. The *Practical Engineer*, of London, says:

> The matter of credit must be looked at from the national point of view, with the interests of bankers and engineers as subordinate. It is all very well to talk of the commercial success of the Germans, but it is a success that has more than anything else caused Russia to detest Germany. The first effect of the German system is that the producer becomes the dependent and servant of the banker. The second effect is to make the purchaser the debt-ridden slave of the banker. The banker becomes supreme. The buyer and the seller are under his hoof for money due, and it follows that they are equally under his hoof in conducting their business and making all their future plans and contracts.
>
> The British engineers must take the initiative, jointly, in forming a financial or trade organization, say in Russia, which will supply information, advise as to opening of credit, and take part of the risk. The British banks should cooperate to a limited extent and only on condition that the Russian banks join. The organization would not be an independent bank, but a cooperative effort to secure the legitimate interests of the British seller and the Russian buyer. The approval, and perhaps the financial assistance, of the British and Russian governments would be necessary, and both governments should be officially represented in the direction of the organization. The buyer would be given clearly to understand that he was not only buying a machine but that he was also borrowing money for which he would have to pay interest. The real price of the machine (that is, the cash-on-delivery price) should be stated and the cost of the loan should be given separately. In that way British capital would be advanced to Russia and mutual trade promoted.

Many of the South American countries attribute their late financial troubles to these long-term credits, together with the speculation they encourage, as the stringency was due to the failure of the dealers to meet the demands of the German banks when the war began.

Russian manufacturers are now preparing to modernize their shops in anticipation of the great manufacturing era that they expect will follow the declaration of peace. Benton Hopkins has already gone there as the representative of two Ohio firms that are to erect twenty-seven large automobile factories in different parts of the country. Over fifty vessels are now en route to Russia with American goods; one recent order placed in this country was for 2,000,000 scythes. The British Board of Trade *Journal* says: "Ural mining works may have to close down for lack of machinery. Not only is it impossible to obtain machinery for new enterprises but spare parts cannot be got for machinery now in use. It is doubted if allied and neutral powers can produce the machinery Germany formerly supplied Russia. All firms desirous of obtaining a share of this business should send salesmen having a good technical knowledge and also a knowledge of the Russian language to the Ural mining region at once." During the past month American and British companies secured 252 deposits of gold and platinum in this region for $15,000,000.

Italy has been a steady buyer in the American iron and steel markets since the war closed the German markets to her. In 1913, Germany sold $1,000,000 more pig iron to Italy than either England or the United States. France, China, Japan, Brazil, Java, Cuba, and Chile have recently made large purchases of American railway supplies. Chile has given the contract for the erection and equipping of several of her railway shops to a New York firm. A Chicago firm of contractors is building the public health works for the government in Uruguay. Other American contractors are building the new port works in Asuncion. Americans have been granted railway and wharfage rights in Nicaragua. Norway has placed orders with most of the shipyards on the Great Lakes and with some on the Atlantic. British Guiana is desirous of obtaining an American engineer to construct its sea defence works, especially one who has had experience with similar work along the Mississippi.

In order to bring their countries into closer relationship with the United States, the leading business men of the South and Central American countries have formed chambers of commerce. Besides, each country has selected a commission of nine men, of which its minister of finance is the chairman, to represent it in the International High Commission, of which Secretary of the Treasury McAdoo is the chairman. This commission will meet in Buenos Aires, Argentina, on April 3, to study and arrange for the application of uniform laws that will assist trade and commerce among the American republics.

When the Interstate Commerce Commission was investigating the cause of the freight embargo of the railways entering New York, several persons said that it was caused by the British and French governments. They stated that any ship that loads without permission is at once requisitioned by the governments. Some cars have been standing in the yards for months because the vessels that were to have taken their freight were commandeered. The vessels of some of the larger lines are now used exclusively for the transportation of war supplies. But a strong American merchant marine is being developed. During the past month, the Gaston, Williams & Wigmore Co. has been formed. It starts with a fleet of fourteen vessels and has contracted for four more. The W. R. Grace Co. acquired the property of the Pacific Mail Steamship Co. with its fleet of steamers and has since purchased a number of others, and is now operating a fleet on the Pacific and the Atlantic. Besides many smaller companies have been formed. In addition every shipyard is working to its fullest capacity. There are now under contract about 350 ships of which fifty-nine are for the United States government and the rest for the merchant marine; many of these, though, are for foreign countries. The American Marine Insurance Co. was also formed to compete with the foreign companies that for nearly a quarter of a century have controlled this field. But this increase of the merchant marine has not been confined to

the United States. Norway and Sweden have so filled their shipyards with orders that it is expected that the war will have ended before all the vessels contracted for will be built. France is lending money to its citizens to buy vessels with. Italy has contracts for twenty-three ships with shipyards on the Great Lakes. Portugal has requisitioned the German vessels interned in its harbor so that they may be used for the transportation of British supplies; Italy and Brazil, it is said, are about to do the same. Japan's shipyards are busier than ever and the only limit to their output is their inability to secure steel as rapidly as desired.

It is quite probable that the International High Commission will accept the following plan for the establishment of rapid and regular maritime communication between the ports of North and South America:

> 1. By the organization of a large company, subscription to which may be made by the public, the balance of the stock, if any, to be taken by the government of the United States and the governments of those Latin-American republics interested, in a proportion to be agreed upon.
>
> 2. The company to be incorporated under the New York laws, but the steamers to be registered in the different countries in proportion to the capital subscribed, and to fly the flag of said country.
>
> 3. For the purposes of customs laws the steamers to be considered as of the nationality of the port, except the coastwise trade in those countries where that trade is reserved for nationals.
>
> 4. The vessels to fulfill certain conditions, *e. g.*, minimum tonnage of 5000 tons and a minimum speed of sixteen miles per hour.
>
> 5. The board of directors shall be composed of representatives appointed by the respective countries in proportion to the capital subscribed.
>
> 6. The payment of the capital subscribed may be made in cash, or by transfer of vessels belonging to the government subscribing, provided said vessels are suitable.

In order that American trade to neutral countries may be inconvenienced as little as possible, Lord Robert Cecil, England's minister of war trade, has established in Washington, under the direction of the British embassy, a bureau that will inform all shippers exactly what goods may be shipped with safety. He says: "We want to give the fairest play to American merchants, who are entitled to all the legitimate trade with neutrals that they can get. We are now working on a specific list for their guidance that will enable them to know what they can do; in other words, we shall throw a better light on the whole contraband question."

Dr. Paul Ritter, minister from Switzerland, says that only certain goods can be shipped to that country, and these must be consigned to the Société Suisse de Surveilance Economique, in Berne; a list of the articles that may be exported may be seen in the various Swiss consulates.

But contrary to the general impression, Great Britain's trade has not been stopped. During 1915, its total export trade was only 20 per cent less than its trade in 1913, which was its greatest year, while in cotton and some lines of iron and steel manufactures its exports to South America were far greater than in 1914, during a part of which the country was not at war. The government is now planning to obtain the lion's share of the world's trade when it is at peace again. The British Association of Chambers of Commerce has asked the government for preferential trading relations between all British countries; for reciprocal trading relations between the British Empire and allied countries; for favorable treatment of neutral countries; for restriction, by tariff and otherwise, on all trade relations with enemy countries. Sir Edward Grey, the foreign secretary, said, after telling of the present movement to expand the foreign trade of the United States: "We must do the same thing quickly. We should have a system of banks throughout South America, Russia, and the other allied countries." Referring to the mining industry, the prime minister of Australia recently said:

> When war broke out nearly all the base-metal trade of Australia was in the hands of a great German combine, which manipulated the markets to suit itself. This trade represented at least £15,000,000 yearly, excluding the value of the gold and silver in the base metals. The policy of the government to encourage Australian industries has resulted in largely extending the facilities for treating the ores of zinc, lead, and copper in Australia. All copper goods required in Australia will soon be made there. After the war, the Australian metal industries will look only to Great Britain and her allies for markets, the aim being to have Australian goods take the place of German.

New South Wales has decided that in the purchase of all supplies for the government, a ten per cent preference will be extended to local, British, and Empire manufacturers as against those of other nations. Canada is planning to develop its resources and to manufacture all articles possible so as to become largely self-sustaining. A government commission is investigating conditions in other countries and a government laboratory is to be erected for the encouragement of its manufacturers. In addition, Canadian bankers last month made a tour through the West Indies to study conditions in order that Canadian banking facilities in that region might be improved. Although not heralding the fact with the blowing of trumpets, Japan has been supplying a good deal of the markets formerly supplied by Germany, especially on the Pacific; it has a most decided advantage there because of its control of the shipping on that ocean. In the meantime Germany has not been thinking only of war. Dr. Reichert, director of the export department, recently said:

> With regard to the commercial policy after the war, the association is clear on the following points: The protective system of Germany, inaugurated by Bismarck, must be maintained. Germany must lay down the conditions upon which her goods are to be exported to the principal foreign markets. She must see that her products are placed upon an equal footing with those of other countries in foreign markets. Where necessary, German customs duties must be raised so as to render the country independent of foreign goods.

In line with its policy of conserving its resources, Germany is now organizing the cattle trade. The organization will have its headquarters in Berlin and will have a board of directors and an advisory committee of twelve members in which the agricultural interests, the chambers of commerce, and the large cities will be represented.

In addition to the loans to England, France, and Russia, the United States has lent $79,000,000 to Argentina, a loan of $15,000,000 having been made in March. Besides, $75,000,000 has just been lent to Canada, while negotiations are being made for additional loans to England, France, and Russia. The Canadian loan is for a period of five, ten, and fifteen years; the Argentina loan last made is for one year.

The Mexican government is now trying to reorganize the financial affairs of the country. It has decided to handle the finances itself and not let this be done by banking and capitalist groups, as has been the custom. It will limit the amount of currency in circulation, both paper and cash, to the present resources of the treasury, which are: $5,000,000 cash; the accumulated bullion in the treasury; $5,000,000 placed at the disposal of the government by the Hennequin regulating commission of Yucatan; the entire taxes for rental and exploitation of mineral lands and forests; the entire mining taxes; and loans that may be obtained on the government property, with a limit of $10,000,000. D. E. J.

* * *

EXPORT BUYERS' LEAGUE

The Export Buyers' League is being organized by Mr. Pels, purchasing agent for the Warner Sugar Refining Co. and the Miranda Sugar Co. of Cuba, and F. M. Moore, buyer for Alexander & Baldwin, Ltd., representing Hawaiian Island sugar interests. Membership in the Export Buyers' League will also include membership in the Purchasing Agents' Association of New York City, a branch of the National Association of Purchasing Agents. The league will include in its membership only those who purchase for export and will not include anyone who personally solicits domestic orders. Further information can be obtained from E. B. Hendricks, secretary of the Purchasing Agents' Association of New York, 129 Lafayette St., New York City.

* * *

A German silver containing about 60 per cent of copper, 14 per cent of nickel, 24 per cent of zinc and from 1 to 2 per cent of tungsten is known as "platinoid" and is used for electrical resistances.

CUSTOMS INFORMATION

DECISIONS ON IMPORTATIONS OF AGRICULTURAL IMPLEMENTS, STEEL BLOOMS AND STRIPS, ETC.

BY JULES CHOPAK, JR.*

The United States Court of Customs Appeals at Washington made a final and important decision to domestic interests, holding that many machined implements must pay 20 per cent duty when imported, notwithstanding alleged free-of-duty claims. The test case involved lawn rakes. Many other articles of the case, however, such as lawn mowers, turf cutting machines, pruning, garden, border and lawn shears and hedge clippers, are affected so as to be excluded from the free-of-duty class. The articles were assessed with duty at 20 per cent, as manufactures of metal. They were claimed free of duty under paragraph 391 which reads:

> Agricultural implements: Plows, tooth and disk harrows, headers, harvesters, reapers, agricultural drills and planters, mowers, horserakes, cultivators, thrashing machines, cotton gins, machinery for use in the manufacture of sugar, wagons and carts, and all other agricultural implements of any kind and description, whether specifically mentioned herein or not, whether in whole or in parts, including repair parts.

As first read, this paragraph would appear to be very broad and take in all kinds of machinery used on vegetation. The Court determined what might be agricultural implements and what were such articles, as follows:

> While, therefore, "agriculture" in its broad application may extend into and include elements of horticulture, viticulture, arboriculture, and other allied industries and pursuits, in its primary significance it extends to and embraces only those parts of all such as pertain to human and incidental animal subsistence—the substantial requirements of life (food) and possibly man's comfort (raiment), and not the merely pleasurable pursuits; the necessities and not the essentially pleasurable or ornamental.

The Court thereupon defined an "agricultural" implement to be one which "serves some purpose in the production of food from the soil or in the raising of domestic animals thereon," following two of its previous decisions. This decision has been religiously followed by the Board of General Appraisers, in consequence of which the many articles aforesaid and all others not coming within the scope of the limited definition of "agricultural implements" must pay 20 per cent duty.

Steel Blooms and Strips

Steel blooms were assessed with duty at 8 per cent under paragraph 110 as Bessemer bar steel. Steel strips were charged 15 per cent under paragraph 110, as steel made by the crucible process and finished by rolling. The importers protested in each case to the Board of General Appraisers, which has just decided the matter. The blooms were claimed free of duty (paragraph 613) as "steel blooms * * * if made Bessemer * * * process, not containing alloys." The Board sustained this claim, saying:

> The evidence in the case conclusively shows that these so-called blooms have been made by the Bessemer process and that they do not contain any of the alloys mentioned in said paragraph 613; that steel bars are made from blooms by either hammering or rolling; that while the particular articles here under consideration were probably in the form of square blooms before they were hammered partially into the shape of bars as imported, they were nevertheless still commercially known and dealt in as blooms, not having been hammered sufficiently to transform them into bars; that these blooms differ from bars in that the former have not the regular and uniform surface dimensions throughout their entire lengths which must always be present in the latter before they are known and recognized throughout the trade and commerce of this country as bars; that this difference in the condition of the two classes of articles is the determining factor by which blooms and bars are distinguished by such trade; and that the commercial understanding as to what constitutes a bloom in no way differs from the common and ordinary meaning thereof. This term is defined by Webster as a large bar of steel formed directly from an ingot.
>
> Inasmuch, therefore, as it is conclusively shown that the articles represent blooms and not bars, free entry therefor is specifically and *eo nomine* provided for in paragraph 613, and we so hold.

The steel strips were proved to be regarded as such in the trade, although they measured over five inches in width and varied in length from 6 to 100 feet. They were made by the Bessemer or the Siemens Martin open-hearth process, and finished by rolling. The Siemens-Martin strips were tempered and polished, while none contained alloys like tungsten. They were not made by the crucible, electric, or cementation processes but were finished by the process known as "strawing"—coloring by heat. A lower claim of 8 per cent was made by the importers, under paragraph 110, as steel "plates," but this claim was decided as invalid because, obviously, such goods are not plates. An alternative lower claim, which was made, at 12 per cent (paragraph 105) as "strips of iron or steel, not specially provided for," was sustained by the Board.

Card Clothing Grinding Machines

The Board of General Appraisers also decided that Dronsfield patent traverse wheel grinders adapted for grinding card clothing were dutiable at 15 per cent, under paragraph 165, as "machine tools," rather than at 20 per cent, as manufactures of metal not specially provided for.

In the March number of MACHINERY, page 624, the customs definition of "machine tools" was given. The government has appealed, however, to the Court of Customs Appeals for a reversal of this decision. The result of the appeal will not be known for several months.

Parts of Sprocket Chains

The Board also decided a protest on made-up sprocket chain, chain in knocked-down condition, and various chain repair parts, classified as sprocket chains at 25 per cent ad valorem under paragraph 126, tariff act of 1913, claimed dutiable as manufactures of metal at 20 per cent under paragraph 167. The protest was sustained as to all items except a transmission chain and inner and outer links for chains, as to which items it was overruled.

The following are some protests now before the Board of General Appraisers, in which testimony may be introduced upholding the government's assessments of higher duties. Any person who can qualify and wishes to testify may do so to enable the Board to reach a correct conclusion.

> *Protest:* Sheep shears. *Assessed:* 30 per cent under paragraph 128 as shears. *Claim:* Free under paragraph 391 as agricultural implements.

If the Customs Court's definition quoted above is strictly followed these sheep shears cannot be admitted free of duty as agricultural implements, since they serve no purpose in the production of food from the soil or in the raising of domestic animals thereon. Shears for cutting wool from sheep are not usually articles in the category of agricultural implements.

> *Protest:* Tubes invoiced as hollow steel bars. *Assessed:* 20 per cent under paragraph 127 as steel tubes. *Claim:* 8 per cent or 15 per cent as steel bars under paragraph 110.

Are these articles tubes or are they bars? The burden of the proof is on the importers to show that they are bars or else the tubes duty will stand. Hollow bars are not the usual bars imported. If the common understanding of bars is solid metal in recognized dimensions—shown by dictionaries or textbooks—then the importer's only hope to succeed is by showing that all wholesale dealers in this country have recognized such articles as "bars," since before October, 1913, when this tariff became law, or since then, only if it is a new article.

> *Protest:* Pedals for bicycles. *Assessed:* 25 per cent under paragraph 120 as finished parts of bicycles. *Claim:* 20 per cent under paragraph 167 as manufactures of metal.

The Board of General Appraisers has already decided that lamps, for instance, are not parts of bicycles, but only "accessories." It is on this theory that the claim is made that pedals are not parts. The impossibility of the claim is at once apparent.

> *Protest:* Centrifugal machines—machinery used in sugar making and for other purposes. *Assessed:* 20 per cent under paragraph 187 as manufactures of metal. *Claim:* Free under paragraph 391 as machinery for use in the manufacture of sugar.

The reason for the government's assessment in this case is that, conceding that the machines are used in the manufacture of sugar, they may be otherwise used. Paragraph 391

* Customs Lawyer, 29 Broadway, New York City.

does not exempt from duty machinery used for sugar making which is susceptible of other uses. Those uses have been shown to the Treasury Department which ordered this assessment. In its instructions to customs collectors, the Treasury Department said:

It appears that many of the machines can be or are used for purposes other than sugar making, such as in dye works, certain chemical processes, laundry extractors, cream separators, etc., only about 10 per cent of those imported being installed in sugar-making plants. When installed in sugar-making plants it appears that it is your practice to pass the merchandise as free of duty as 'machinery for use in the manufacture of sugar' although identical with machinery installed for other purposes which is assessed for duty at 20 per cent.

The department is of the opinion that the general or chief use of the machinery should govern, and when the machinery, even though installed in a sugar-making plant, is identical with machinery used chiefly for purposes other than the manufacture of sugar, as in the case of the centrifugal machines in question, it should not be permitted free entry, but, if in chief value of metal, should be assessed with duty at 20 per cent.

The rule is not uniform that goods actually used for the tariff mentioned purpose are not classifiable as such. Sometimes the actual use settles the matter, notwithstanding the susceptibility to different use. On the other hand, we remember a court decision wherein it was held that circular disks which were actually used as ends for spools were held dutiable as circular saw plates because of their identity as such.

Protest: Points or needles of diamond or sapphire used for phonographs. *Assessed:* 25 per cent under paragraph 374 as parts of phonographs. *Claim:* 10 per cent under paragraph 161 as jewels for use in watches, meters, etc.; or 20 per cent under paragraph 357 as precious or semi-precious stones.

The 25 per cent assessment here cannot be upheld, because these points, as imported, are not parts of phonographs. They have to be further manipulated and really identified with phonographs before this rate can be taken. However, the 10 per cent claim as jewels can be disregarded for the proof would never be that their use is as such. The points are dutiable at 20 per cent—not under paragraph 357 as precious stones—under paragraph 81 as manufactured mineral substances. This view has been judicially declared both by the Board and Customs Court. The Board recently held that flat pieces of real sapphire, polished and sharpened on two sides, used in cutting tools such as chisels, etc., classified as a manufacture of semi-precious stones at 45 per cent ad valorem under paragraph 98, tariff act of 1913, were dutiable as a mineral substance, manufactured, at 20 per cent under paragraph 81. The Court of Customs Appeals has previously so decided on pieces of sapphire used as "bearings for electrical or other delicate measuring instruments," in the case of U. S. vs. General Electric Co., 4 Ct. Cust. Appls., 287.

Protest: Aluminum foil, 21 inches by 9 inches by 0.0005 inch thick. *Assessed:* 20 per cent under paragraph 167 as manufactures of aluminum. *Claim:* 3½ cents pound under paragraph 143 as aluminum sheets.

The point here is if the above dimensions are of aluminum in "sheets." If not, the charged duty is correct. If so, the lower duty should be fixed. The government claims that 0.0005 inch is too thin for a sheet. There should be no difficulty in upholding this claim if it became necessary for the government to do so. Aluminum in "plates, bars, sheets, strips, and rods" is admitted at 3½ cents per pound duty. Judging sheets from the accompanying words, they must be of a more substantial character than the present dimensions show the goods to be. When the duty on this merchandise was considered by the Treasury Department, its conclusion was governed somewhat by previous decisions of the Board of General Appraisers holding that zinc foil and a foil in chief value of copper, both commercially known as "foils," were dutiable as here classified and not as "sheets." So also was gold foil distinguished from gold leaf. The department adds, in speaking of the thickness of aluminum sheets:

For the purpose of such classification (as sheets) you will consider aluminum in the form of either sheets or strips not more than 0.0015 of an inch and not less than 0.0003 of an inch in thickness, as foil.

THE PROGRESS OF WIRELESS TELEPHONY

An interesting account of the progress made in wireless telephony—generally known among scientists and investigators as "radio" telephony—was given in a lecture before the American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., by Ernst F. Alexanderson of the General Electric Co., Schenectady, N. Y., at the society's meeting March 4. Mr. Alexanderson has been the chief investigator and the designer of the most important apparatus used in connection with this work at the General Electric Co.

One of the main difficulties in wireless telephony is to cause a current of, say, 50 or 100 kilowatts, to operate or respond to the vibrations caused by the human voice in a telephone transmitter with a current of a fraction of a watt. This problem, however, has been solved by means of a special device or regulator interposed between the transmitter and the aerial antennae. For successful radio telephony, currents of from 50 to 500 kilowatts are required in order to overcome static conditions in the atmosphere. The experiments recently undertaken by other investigators, which proved successful in transmitting messages from Washington to Paris and the Hawaiian Islands, were undertaken with much less power, but under perfect static conditions. In commercial practice, however, the apparatus must provide ample power margin even for comparatively unfavorable static conditions. A high frequency current is required, and a large generator has been built having a frequency of 50,000 cycles per second. Wireless messages are being transmitted daily between Schenectady and New York with a small generator of the same type, designed for 100,000 cycles per second. It appears that there are no limitations to the possibilities of wireless telephony, as practically all of the problems have been solved, and it is only a question of whether the commercial world is willing to pay the price that this service will cost, because the apparatus will be costly, and the transmission of messages of this kind cannot be done cheaply.

It is not expected that radio telephony will ever compete with ordinary telephone service for private subscribers. It would be too expensive and, probably, generally unsuitable for that service; but there are three distinct services for which it would be especially suitable. One is for long distance telephone service over water where it would be impossible or impracticable to use wires as conductors. The second is for long distances over land, where the use of radio telephony may be cheaper than the erection and maintenance of long telephone lines subject to derangement by storms and snow. It is possible that arrangements can be made so that a radio telephone system might be used between two cities like New York and Chicago, and when subscribers to the regular telephone service in either of these cities desire to speak to subscribers to the regular system in the other city, the radio system could be coupled into the regular net system, so that the message could be transmitted from the subscriber to the central in one city by wires; from this central to a central in the other city by radio telephony; and from this central to the subscriber by wires. The third valuable use for wireless telephony would be in the case of a central office or agency that wanted to send out messages to a great number of branch offices all over the country. In that case the sending apparatus, which is the most costly part, would be installed at headquarters, while all the branch offices would have receivers only. In this way orders or messages could be given from headquarters at any time, and without the need of private wires to all the branches. Of course the branch offices would not be able to reply if they had receivers only, but in many cases that would be unnecessary.

The general conclusions to be drawn from Mr. Alexanderson's address were that wireless telephony is no longer an experiment, but has entered upon its commercial development; that its future application depends mainly upon whether the commercial world considers the service worth the price; and that there are a number of distinct services for which it is vastly superior to ordinary telephone service.

ARTHUR J. BALDWIN

Arthur J. Baldwin, recently elected president of the Hill Publishing Co., New York City, is a well-known lawyer of pronounced business ability, for many years the intimate friend and advisor of the late John A. Hill, and therefore familiar with his ideals and policies. Mr. Baldwin is admirably qualified to carry upward and onward the great enterprise committed to his charge, and his administration starts with the good wishes of all friends of the Hill organization, among whom are included its competitors. Mr. Baldwin is an official in five other business corporations, and has an extensive legal practice; but we are informed that he will devote his entire time and energy to the business of the Hill Publishing Co.

PERSONALS

F. L. Cone of the Windsor Machine Co., Windsor, Vt., has resigned his position as superintendent.

William Arend has been appointed general superintendent of the Cisco Machine Tool Co., Cincinnati, Ohio, succeeding George Spinner.

E. P. Worden, formerly with the Fred M. Prescott Steam Pump Works, Milwaukee, Wis., has been appointed chief engineer of the Henry R. Worthington plant, Harrison, N. J.

F. D. Walden, formerly of the Heald Machine Co., Worcester, Mass., has taken a position with the Davis Machine Tool Co., Inc., Rochester, N. Y., as manager in charge of operations.

Peter Plantinga, formerly with the Heald Machine Co., Worcester, Mass., has taken charge of the mechanical engineering department of the Davis Machine Tool Co., Inc., Rochester, N. Y.

Dewitt Tappan, for eleven years with the Watervliet Arsenal, Watervliet, N. Y., has resigned the position of planning room foreman to enter the employ of the Veeder Mfg. Co., Hartford, Conn., as assistant superintendent.

J. E. Lawton, for the last nine years inspector and chief inspector of the Panama Canal, has resigned to take a position as consulting engineer and sales manager for Ward & Co., manufacturers' agents, Washington, D. C.

Dr. F. W. Cunningham has resigned his connection with the research and development work of the Newark plant of the General Electric Co. to join the engineering research staff of the Powdered Coal Engineering & Equipment Co. of Chicago.

Arthur Churchill, in charge of the small tools department of Charles Churchill & Co., Ltd., London, England, has been elected managing director succeeding his brother, the late Charles Henry Churchill, whose death occurred February 8.

L. E. Jordan, treasurer and general manager of the Vulcan Process Co. Inc., Minneapolis, Minn., has disposed of his interests in the company and has been succeeded in office by Clifford N. Lockwood, who will fill the position of treasurer and general manager.

P. P. Bourne, formerly chief engineer of the Blake & Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Co. in connection with special engineering work, and is located at the main office, 115 Broadway, New York City.

Herbert J. McCauley has been appointed district sales manager for Julius Blum & Co., New York City, in the western New York and Pennsylvania territory. A warehouse at 308-314 Terrace, Buffalo, N. Y., has been opened, carrying a full stock of strip and bar steel, tubing and other products handled by the company.

Thomas F. Williams, formerly chief mechanical engineer of the Aeromarine Plant & Motor Co., Avondale, N. J., has taken the position of chief consultant of the board of engineering research, mechanical applications, of the Powdered Coal Engineering & Equipment Co., of Chicago, and will direct the research work of the company in the carburization of comminuted fuel and the application of automatic mechanical regulation devices.

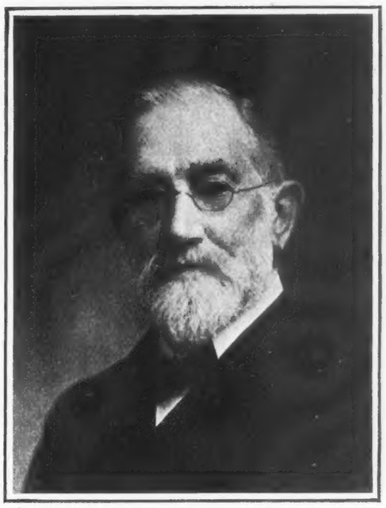
W. S. Chase, for thirteen years head of the sales department of the National-Acme Mfg. Co., Cleveland, Ohio, has resigned to devote himself to personal affairs. He will spend much of his time at his ranch in Meridian, Idaho. Mr. Chase's connection with the National-Acme Mfg. Co. dates from a time soon after the company was incorporated, and those who have worked with him are united in a high appreciation of the importance of his services in building up the business.

Benton Hopkins, representing Samuel Austin & Son Co., Cleveland, Ohio, engineers and builders, and the American Engineering Co., Alliance, Ohio, has sailed for Russia to open the way for the construction of a chain of automobile plants. The plant immediately under consideration is the first one of a group of twenty-seven large self-contained plants which will be erected in Russia as part of a great movement for placing Russia on the map industrially. The first plant will be used for the manufacture of automobiles and motor trucks.

CHARLES CHURCHILL AND CHARLES HENRY CHURCHILL

Expressions of the deepest regret for the death of Charles Churchill and his son Charles Henry Churchill of London, England, have come from many American machine tool builders, among whom the elder Mr. Churchill, especially, had a wide acquaintance extending over many years. Charles Churchill was well known as the founder of the machine tool importing firm of Charles Churchill & Co., Ltd., and as he had been in poor health for several years his death was not unexpected. His health necessitated his withdrawal from active business about a year ago, when his son, Charles Henry, succeeded him as managing director. The elder Mr. Churchill's death occurred on February 15, only seven days after that of his son.

Mr. Churchill was born in Hamden, Conn., 1837, and received his education in the schools of that town. His first business experience was gained with his father who was at that time engaged in the manufacture of augers. Subsequently Mr. Churchill and his father were sent to England by Thompson, Langdon & Co. of New York to superintend the erection of some wire-coating machinery which had been exported by that firm. The interest taken in this equipment impressed Charles Churchill deeply and this fact, together with the knowledge of the British machine trade gained by his work in England, led to the establishment of the machinery importing firm of Charles Churchill & Co. in 1865. This firm was the first to engage actively in the business of importing American machine tools for sale in Great Britain. Those who knew the elder Mr. Churchill and are familiar with the rapid progress made by his firm to the position of importance which it now occupies, will readily understand the peculiar qualifications of the man for the business which he selected as his life's work. He was both aggressive and progressive, and possessed of a genial disposition which enabled him to make new friends easily and hold the esteem of old acquaintances. These were powerful factors in gaining customers for the firm during the early years of its existence, and the importance of their effect upon the growth of Mr. Churchill's business was second only to the reputation for absolute integrity which was built up by years of honest trading. Although Mr. Churchill had long been a resident in Great Britain, he remained an American citizen to the last and was often heard to express himself as being extremely proud of the fact. Mr. Churchill is survived by two sons, one of whom, Arthur, is at present in charge of the small tools department of the firm.



Charles Churchill

Charles Henry Churchill was born in London in 1864 and received his education in the schools of that city. At an early age he entered his father's business and about a year ago succeeded him as managing director of the firm of Charles Churchill & Co.

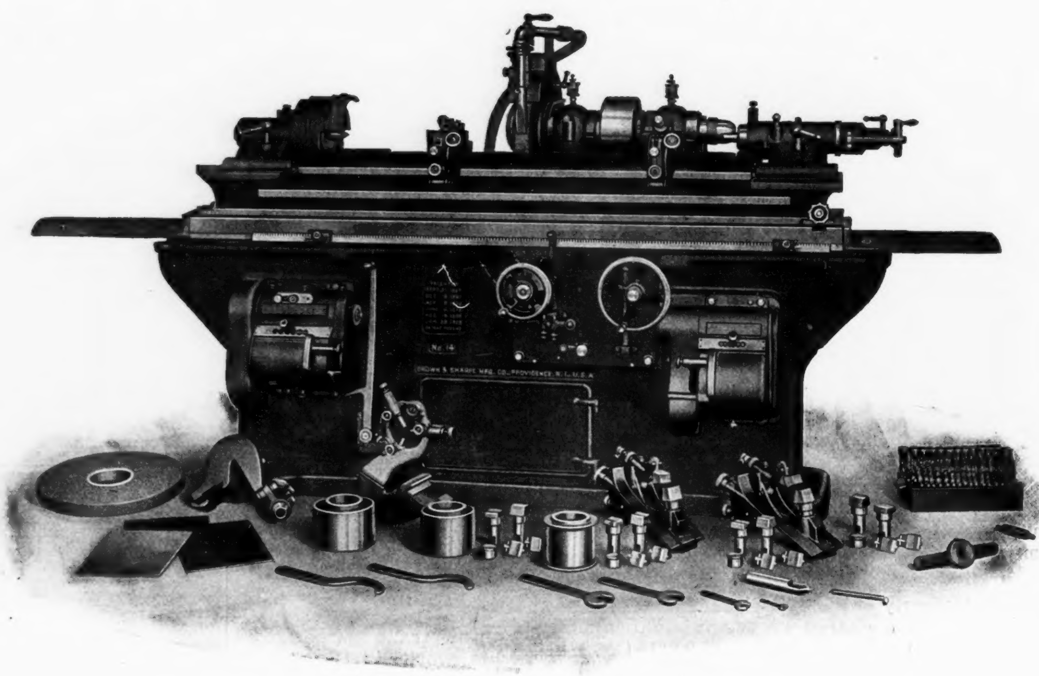
OBITUARIES

Melville H. Barker, general manager of the American Tool & Machine Co., Boston, Mass., died at his home in Dorchester, Mass., March 12, aged seventy years, following a brief illness, of pneumonia. Mr. Barker was a charter member of the National Metal Trades Association.

Eugene E. Garvin, vice-president of the Garvin Machine Co., New York City, which was founded by his father, the late Hugh R. Garvin, died at his home in Englewood, N. J., March 20, aged fifty-eight years. Mr. Garvin was born in Hartford, Conn., and has been connected with the Garvin Machine Co. during his entire business career, for the last twelve years as vice-president.

Edward T. Betts, vice-president and treasurer of the Betts Machine Co., Wilmington, Del., builder of boring mills, planers and other machine tools, died at his home in Wilmington February 28, aged sixty years. Mr. Betts was one of the prominent citizens of Wilmington. He was a member of the Wilmington Savings Fund Society, and a director of the Wilmington Trust Co. He is survived by a widow, a daughter and a son, Edward T. Betts, Jr.

William H. Dayton, master mechanic of the Excelsior Needle Co., Torrington, Conn., died suddenly of heart failure March 6, following a brief illness. He was born in Torrington, then



A Grinding Machine That Enables You to Keep Good Operators

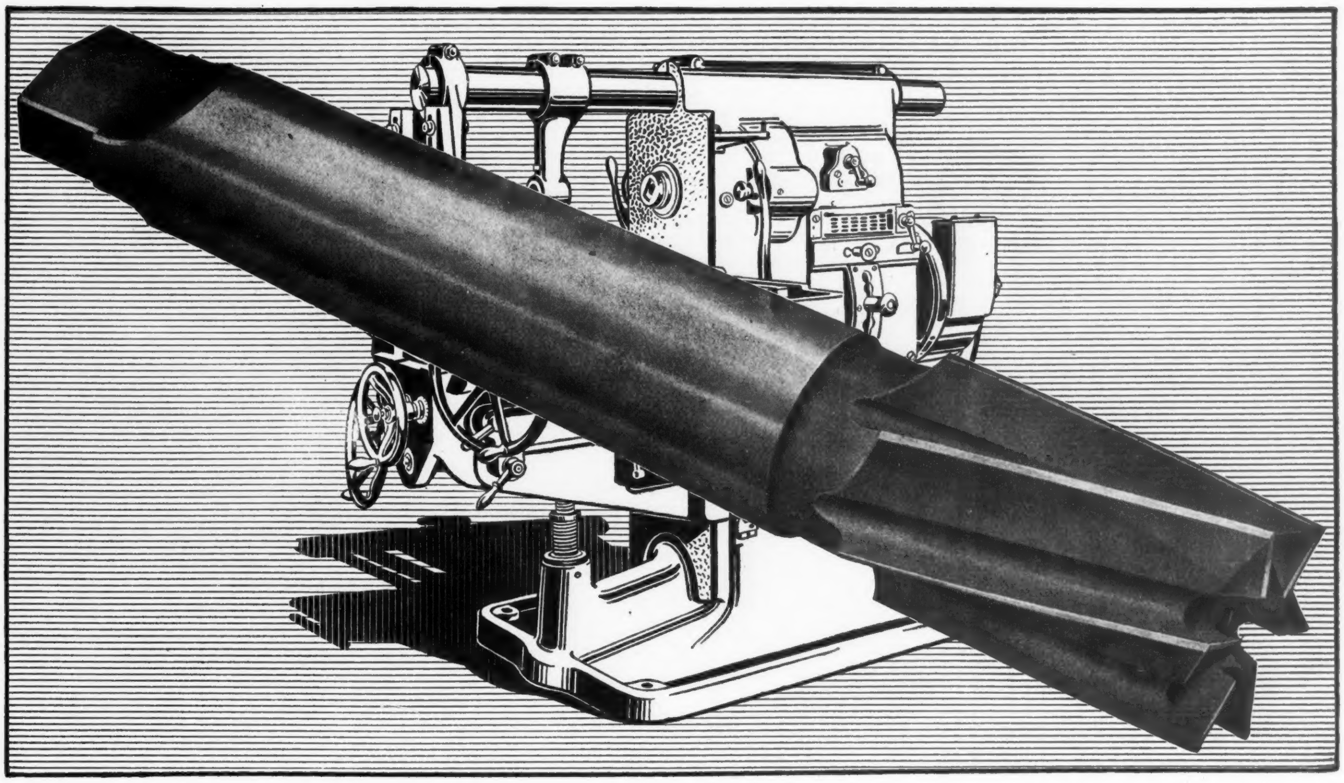
A good grinding machine operator is usually a man of intelligence and sound judgment. Suppose he gets a job in a shop equipped with antiquated, unhandy grinding machines. Of course he can get better results from those machines than a less skillful man, but he soon realizes that it takes a considerable amount of mental and physical effort to even get what he knows to be indifferent results. He realizes that he is not working with equipment that gives him an opportunity to demonstrate his real worth, with the result that he becomes dissatisfied and seeks a change.

The same operator with a Brown & Sharpe Grinding Machine, say our No. 14 shown above, could produce results that would satisfy him and please you. And the energy he would use would not be anywhere near as great. He would have the satisfaction of working with an efficiently designed machine that enabled him to produce satisfactory results and demonstrate his value also. He would be handling a machine that is quickly set up, easily and rapidly operated and which produces accurate, uniform, high-grade work at a maximum rate. Why not write for descriptive circular describing the features of this machine in detail?

Brown & Sharpe Mfg. Co.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash; Portland Machinery Co., Portland, Ore.



Milling Efficiency That Counts

for profitable results, especially on heavy work, is a combination of powerful machines, good cutters and intelligent operators. A weak link in this chain means a corresponding reduction in output.

You may have a powerful machine, but if the cutters cannot use the power to the extent they should, just so much production is held in check. You may have a capable operator, but if his time is wasted changing cutters that cannot hold a good cutting edge under heavy cuts you can easily figure what an idle machine, a waiting operator and constant grinding will cost you.

Where Brown & Sharpe Cutters are Used

maximum results are produced and the power of a machine is utilized to the fullest extent. They stand up under severe service, taking heavy cuts at coarse feeds, turning up big, coarse chips with the rapid, free cutting action for which these cutters are noted. Above all, this kind of service is continuously rendered for a long period; they are not only productive, but long-lived.

Our General Catalogue, gladly sent on request, shows our entire line of standard cutters.

Providence, R. I., U. S. A.

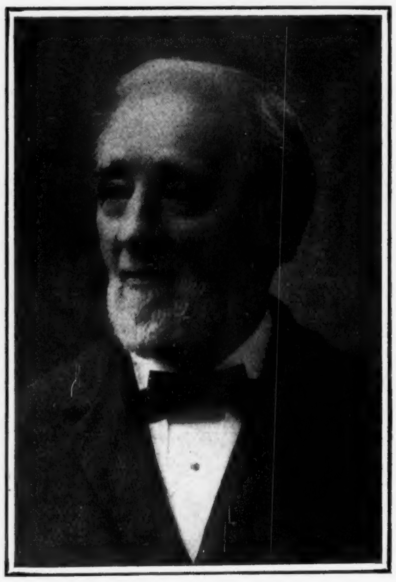
CANADIAN: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt a.M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong Machinery Co., Manila, P. I.

known as Wolcottville, in 1840. His father was Arvid Dayton, a builder of melodeons and organs, from whom no doubt he inherited his mechanical genius. Mr. Dayton was first employed in his father's shop but joined the newly organized Excelsior Needle Co. in 1866, remaining in its employ until his death. His many inventions concerned the machinery used in the products of the company—sewing machine and knitting machine needles, bicycle spokes, nipples and pedals. He was also the inventor of the swaging machine which bears his name and has been sold for many years by the company. While he had not been in vigorous health for some time, he was actively engaged in his usual duties and was constantly devising new methods and machinery for manufacturing. Mr. Dayton served the borough of Torrington as a burgess and later as warden from its organization in 1888 for twenty-four years. He is survived by a son, James M. Dayton, and three grandchildren.

FRANKLIN ALTER

Franklin Alter, president of the American Tool Works Co., Cincinnati, Ohio, died at his home in Cincinnati, February 23, aged eighty-four years. For many years Mr. Alter has been a conspicuous figure in the machine tool industry of Cincinnati. He was born in Carlisle, Pa., and his boyhood was spent at Hagerstown, Md. At the age of nineteen, he went to Pittsburg with the intention of going to New Orleans by steamer down the Ohio and Mississippi rivers, but on stopping a few days at Cincinnati waiting for the steamer to load he decided to locate there. His first position was with a wholesale hardware dealer, and he finally became sole owner of the concern. Expansion of his business brought him in contact with the machine tool industry, and in 1900 he purchased a controlling interest in the Davis & Eagan Co., which was reorganized into the American Tool Works Co. The company has grown to be one of the largest machine tool building concerns in the country, and is now erecting a new plant which will afford about 238,000 square feet of floor space. It is a matter of regret to those associated with him that Mr. Alter did not live to see the completion of the work in which he took so much pride and interest. He is survived by a widow, three daughters and two sons; of the latter Robert and L. W. S. are, respectively, secretary and foreign trade manager, and production engineer of the American Tool Works Co. Mr. Alter's death will not affect the general policy of the company, and its business will be continued on the same lines as heretofore.



Franklin Alter

COMING EVENTS

April 11-14.—Spring meeting of the American Society of Mechanical Engineers at New Orleans, La. Headquarters, Hotel Grunewald. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

April 13-14.—Conference on engineering cooperation to discuss cooperation among engineering organizations, methods, aims, legislation, employment, exchange of ideas, etc. Monadnock Block, Chicago, Ill., headquarters. C. E. Drayer, secretary, Cleveland Engineering Society, Cleveland, Ohio.

April 27-28.—Annual meeting of the National Metal Trades Association in New York City. Hotel Astor, headquarters. H. D. Sayre, secretary, Peoples Gas Bldg., Chicago, Ill.

May 16-17.—Annual meeting of the National Association of Manufacturers at the Waldorf-Astoria Hotel, New York City. George S. Boudinot, secretary, 30 Church St., New York City.

June 12-16.—Midsummer cruise of the Society of Automobile Engineers on the Steamship "Noronic," leaving Detroit June 12 and returning June 16. Reservations can be made by application to W. H. Conant, treasurer, 601 Kerr Bldg., Detroit, Mich.

June 14-16.—Annual meeting of the Master Car Builders Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 14-21.—Annual meeting of the Railway Supply Manufacturers Association at Atlantic City, N. J., in connection with the A. R. M. M. and M. C. B. Associations. J. D. Conway, secretary and treasurer, 2136 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual meeting of the American Railway Master Mechanics Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 27-July 1.—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer, C. H. & D. Ry., Lima, Ohio.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Beloit College, Beloit, Wis. Catalogue 1915-1916 with announcements for 1916-1917.

Columbia University, New York City. Announcement of Division of Chemistry for 1916-1917.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the College of Engineering, 1916-1917.

Yale University, New Haven, Conn. General catalogue 1915-1916, containing calendar, outline of curriculum, etc.

American Museum of Safety, 14-18 W. 24th St., New York City. Special bulletin on the award of the Travelers Insurance Co.'s medal for 1915 to the Hudson & Manhattan Railroad Co., Wilbur C. Fisk, president, for achievement in accident prevention among its personnel and for promoting safety for the traveling public. The booklet contains a historical article on the Hudson Tunnel Railroad Co., showing the plan of the Hudson & Manhattan Railroad tunnel system and describing safety devices in cars, shops and power stations.

American Museum of Safety, 14-18 W. 24th St., New York City. Special bulletin on the award of the Louis Livingston Seamen medal for 1915 to the Diamond Match Co., William Armstrong Fairburn, president, for progress and achievement in the promotion of hygiene and the mitigation of occupational disease. This booklet contains an article on the welfare activities of the Diamond Match Co. and illustrates the tennis courts, gymnasium, lunch and rest rooms, library, emergency room and other features provided for the recreation and comfort of its employes.

Franklin Institute, Philadelphia, Pa. The city of Philadelphia, acting on the recommendation of the Franklin Institute, has awarded the John Scott legacy medal and premium to Clement F. Street of New York City, for the Street locomotive stoker. The increase in size of locomotives during recent years has imposed labor on firemen beyond the endurance of most men, and locomotive stokers have come to be regarded as necessities for the largest and most powerful locomotives. The Street mechanical locomotive stoker has been designed for keeping the fire in direct relation to all conditions of operation and for securing the maximum output. Over six hundred of these stokers are in use.

NEW BOOKS AND PAMPHLETS

The Testing of Hydrometers. 16 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 16.

United States Standard Tables for Petroleum Oils. 64 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 57.

Microstructural Changes Accompanying the Annealing of Cast Bronze. By Henry S. Rawdon. 17 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 60.

Railroad Track Scales, Specifications and Capacity Rating. 28 pages, 8 by 10½ inches. Issued by the Bureau of Standards, Department of Commerce, Washington, D. C.

These specifications issued in mimeograph form for railroad track scales, give complete data for calculating the sizes of members of scales of the straight lever and pipe lever types.

Colorado Industrial Plan. By John D. Rockefeller, Jr., 726 Broadway, New York City. 94 pages, 4 by 6¾ inches.

This booklet contains a complete copy of the plan of employes' representation—or "industrial constitution"—and the agreement between the Colorado Fuel & Iron Co. and its employes adopted at the coal and iron mines of the company.

Spring Engineering. By Egbert R. Morrison. 75 pages, 6 by 9 inches. Illustrated. Published by Egbert R. Morrison, Sharon, Pa. Price, $4.

This work treats of the fundamental principles of spring design, elliptic or leaf springs, spiral springs, heavy helical springs, grouped helical springs, conical helical springs, wire springs, elliptical and rectangular sections, and includes mathematical tables. The author is well known to MACHINERY's readers as a contributor, and the articles in part are reprints of chapters contributed by him to MACHINERY.

Dams and Weirs. By W. G. Bligh. 206 pages, 5½ by 8½ inches. 122 illustrations. Published by the American Technical Society, Chicago, Ill. Price, $1.50.

This is an analytical and practical treatise on gravity dams and weirs, arch and buttress dams, submerged weirs, and barrages. It deals with the various subjects treated from a theoretical point of view mainly, which, in dam construction, is highly important, as calculations are absolutely necessary to safe design. In addition there is, however, much information of direct practical application.

Statistics of Railways in the United States, Twenty-seventh Annual Report. 785 pages, 9 by 12 inches. Published by the Interstate Commerce Commission, Washington, D. C.

This is the twenty-seventh annual report of railway statistics. The contents comprise statements of receiverships, mileage, classification of railways, equipment, railway employes, capitalization and railway property; selected statements and assignments; income and profit and loss statements; taxes; investments in road and equipment; and abstracts of reports rendered by steam railway companies in three classes.

Mechanical World Electrical Pocketbook for 1916. 240 pages, 4 by 6 inches and diary and memoranda for 1916 additional. 130 illustrations. Published by Emmott & Co., Ltd., Manchester, England, and Norman Remington Co., Baltimore, Md. Price, $0.30.

This compilation of electrical data is published yearly and is well known to electrical engineers, electricians, etc., in Great Britain and America. It treats of a great variety of electrical matters and includes many tables. Anyone needing a small treatise on electricity of a strictly practical nature will make no mistake in purchasing one of these year books.

Practical Perspective. By Frank Richards and Fred H. Colvin. 58 pages, 4½ by 6⅞ inches. 64 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $0.50.

This little treatise on making isometric mechanical drawings has just been issued in the fourth revised edition. It treats of the principles of isometric perspective and is illustrated with many examples. The use of isometric paper, which is also sold by the publishers, is described. This paper makes the construction of isometric sketches without preliminary layouts very simple, and the art can be quickly mastered by anyone at all handy with the pencil.

Concrete and Reinforced Concrete. By W. L. Webb and W. H. Gibson. 240 pages, 4½ by 7 inches. 118 illustrations. Published by the American Technical Society, Chicago, Ill. Price, $1.50.

This treatise is intended for the use of the engineer or contractor and also for those seeking general information upon the subject. The authors have endeavored to present the subject in as simple and concise a manner as possible. The book covers the composition and treatment of concrete, and describes the mixing and laying of concrete for different purposes, including T-beams, footings, piles, retaining walls, culverts, girder bridges, building blocks, fence posts, walks and curbs, and flat-slab construction. The general theory of flexure in reinforced concrete, and the practical calculation and design of beams and slabs are dealt with. The book is neatly bound in flexible leather.

House Wiring. By Thomas W. Poppe. 125 pages, 4 by 6 inches. 95 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $0.50.

This little treatise describes and illustrates methods of installing electric light wiring, bell wiring and burglar alarm wiring, and is intended for the instruction of electricians, helpers and apprentices. The instructions given are in conformity with the rules of the National Board of Fire Underwriters. The chapter heads are as follows: Showing the Plans and Layout of the Electrical Work; Flexible Metallic Wiring Systems; Installing Rigid Conduit;

Combining Flexible and Rigid Conduit; Wiring and Switch Diagrams and Connections; Grounding Metallic Conduit Systems; Knob and Tube System; Installing Bell Wiring and Appliances; and Installing Burglar Alarm, Wiring and Appliances.

Magnetic and Other Properties of Iron-Silicon Alloys, Melted in Vacuo. By Trygve D. Yensen. 67 pages, 6 by 9 inches. 40 illustrations. Issued by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 83. Price, 35 cents.

The bulletin describes the methods employed in producing a number of iron-silicon alloys, which the author has subjected to mechanical and electrical tests. The tests show that silicon increases the mechanical strength of iron in almost direct proportion to the amount added, until the maximum strength is reached with a silicon content of about 4.5 per cent. The elastic limit of this alloy is 94,000 pounds per square inch, and the ultimate strength 105,000 pounds. The magnetic properties of the vacuum alloys are remarkable. The maximum permeability is above 50,000 and the hysteresis loss is only one-eighth to one-third of that for commercial silicon steel.

Lathe Design Construction and Operation. By Oscar E. Perrigo. 469 pages, 6 by 9 inches. 341 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $2.50.

This is a revised and enlarged edition of a book originally published in 1907. The aim of the author has been to present in as comprehensive a manner as possible the history and development of the lathe and to describe its practical use on various classes of work. In the revised and enlarged edition of this work a chapter has been added dealing with lathe installation and management, milling, drilling and grinding attachments, and their use, methods for turning tapers and spherical surfaces, and various odd jobs that may be performed in a lathe. The book deals completely with the history of the lathe; classification of lathes; lathe design, covering all the various details required; lathe attachments; rapid change gear mechanisms; tests performed on lathes; lathe tools and the operation of engine lathes, turret lathes, and special lathes.

Elevators. By John H. Jallings. 217 pages, 5½ by 8½ inches. 172 illustrations. Published by the American Technical Society, Chicago, Ill.

This is a practical treatise on the development and design of hand, belt, steam, hydraulic and electric elevators. The author has for twenty years been superintendent and chief constructor with a well-known elevator company, and writes, therefore, with the force of authority behind him. The work is divided into three main sections, the first of which deals with hand- and belt-power elevators the second, with steam and hydraulic elevators, and the third, with electric elevators. As a general descriptive treatise covering the whole field of elevators, the book is to be recommended to anyone who requires a complete review of the subject. The theoretical principles are not dealt with in great detail, the work, apparently, not having been intended to be a designer's handbook, but rather a detailed history of the mechanical and electrical developments of various types of elevators.

Oxy-acetylene Welding and Cutting—Electric, Forge and Thermit Welding. By Harold P. Manly. 215 pages, 4¼ by 6½ inches. 56 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, bound in cloth, $1; bound in leather, $1.50.

The work deals with metals and alloys; heat-treatment; welding materials; acetylene generators; welding instruments; oxy-acetylene welding practice; electric welding; hand forging and welding; soldering, brazing and thermit welding; and the oxygen process for removal of carbon. The author's object was to cover the several processes of welding and other processes which are so closely related as to make them practically a part of the whole subject of jointing metal to metal with the aid of heat. For this reason, annealing, tempering, hardening, heat-treatment and the restoration of steel have been included. The book is condensed, much more information being contained than might be inferred from a casual examination of the small volume.

Industrial Leadership. By H. L. Gantt. 128 pages, 5 by 7½ inches. Published by Yale University Press, New Haven, Conn. Price, $1.

This book, by one of the best known of the exponents and organizers of scientific management plans, contains a series of lectures delivered by the author in the Page Lecture Series, 1915, before the Senior Class of the Sheffield Scientific School at Yale University. It contains an exposition of the fundamental principles of scientific management, divided into five chapters—Industrial Leadership, Training Workmen, Principles of Task Work, Results of Task Work, and Production and Sales. The freedom from dogmatic doctrine and the ability to see far beyond the narrow limits of mere systems, which characterize all of the author's writings and public utterances, are in evidence in this book, and it can be well recommended to all those who wish to obtain a sound conception of the fundamental principles upon which scientifically planned management must be based in order to be successful. The book is full of veritable gems of thought relating to the broader aspects of industrial work.

Indexing and Filing. By E. R. Hudders. 292 pages, 6 by 9 inches. Numerous illustrations. Published by the Ronald Press Co., New York City. Price, $3.

This book has been written with a view to formulating rules covering the indexing and filing of records, such as are ordinarily used in commercial organizations. The scope of the work can best be indicated by giving the headings of the twenty-nine chapters of which it consists. These chapters deal, respectively, with Terminology and Definitions; Indexes; Rules for Writing Indexes; Rules for Filing Index Cards; Filing of Papers; Direct Alphabetic Filing; Alphabetic-Numeric Filing; Numerical Filing; Geographic Filing; Subject Filing; Lost Papers; Transferring; Central Filing Department; Classing and Grouping of Records; Notation; Information and Data Files; Catalogue and Pamphlet Filing; Purchase Records; Sales Records; Credit Records; Filing of Sales Invoices; Filing of Purchase Invoices; Check and Voucher Filing; Filing of Electrotypes and Cuts; Filing Equipment; Filing in Lawyer's Offices; Architectural Filing; and Files of an Accountant.

Starting, Lighting and Ignition Systems. By Victor W. Page. 509 pages, 5¼ by 7½ inches. 295 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $1.50.

This book contains descriptions of the various forms of electrical ignition systems used in internal combustion engines and includes chapters on the starting and lighting systems of automobiles. In addition to the chapters dealing specifically with the ignition, starting and lighting systems, the book contains a simply written treatise on elementary electricity. The chapters dealing with ignition methods are headed Battery and Coil Ignition Methods, and Magneto Ignition Systems. The electric starter is dealt with in two chapters, one on elementary principles, and one describing typical lighting and starting systems. A special chapter is devoted to starting system faults and their location, and in addition, there is a chapter on miscellaneous electrical devices used in connection with automobiles. The book should prove of value to owners of automobiles and repair men, as well as to designers and others who are interested in the different devices employed in connection with starting, lighting and ignition systems.

Metric System in Export Trade. By Samuel W. Stratton. 80 pages, 6 by 9 inches. Illustrated. Published by the U. S. Government, Washington, D. C., as Senate Document No. 241.

This is a report to the International High Commission relative to the use of the metric system in the export trade by the director of the Bureau of Standards. Its circulation among manufacturers at this time when so many are laying plans for developing foreign trade should be generally helpful. It answers the specific questions: What proportion of manufacturers have adopted the metric system in preparing goods for export? Has experience warranted an expansion of this policy? What are the chief objections to such action? Are certain lines less adaptable than others? What will be the effect upon the scale and tool trades of any systematic movement in this direction? Ought we to recommend the compulsory instruction in our schools in the metric system, or might it be limited to high schools? Practical suggestions and data on the metric system follow. Examples of American products made to conform to the requirements of metric measure countries are also included.

NEW CATALOGUES AND CIRCULARS

Van Emon Elevator Co., 46-54 Natoma St., San Francisco, Cal. List of second-hand machine tools for sale.

Economy Engineering Co., Willoughby, Ohio. Circular of electric hoists made in capacities from 1000 to 10,000 pounds.

Phoenix Mfg. Co., Eau Claire, Wis. Catalogue and price list of Phoenix and Conradson turret attachments for engine lathes.

Enterprise Machinery Co., 32-34 S. Clinton St., Chicago, Ill. Circular of "Emco" No. 1 bench drill, speeded from 1500 to 5000 R. P. M.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Looseleaf catalogue containing bulletins, with prices and dimensions, of electric controlling apparatus.

Wright Mfg. Co., Lisbon, Ohio. Catalogue 7 covering the line of chain hoists, steel trolleys and hand cranes manufactured by this company.

Skinner Chuck Co., New Britain, Conn. Circular illustrating independent lathe chucks with solid reversible jaws, giving dimensions, prices, etc.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Booklet of direct- and alternating-current electric fans.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin E-38 descriptive of the Duntley universal electric hammer drill and the work for which it is adapted.

Link-Belt Co., Chicago, Ill. Catalogue 213 illustrating Link-Belt elevators, conveyors and machinery for handling, preparing and storing gravel, stone, sand, etc.

Union Switch & Signal Co., Swissvale, Pa. Booklet describing the forging and foundry departments and machine shop of this company and listing the forgings manufactured.

Tirrill Gas Machine Lighting Co., 103 Park Ave., New York City. Booklet on Tirrill equalizing gas machines, high efficiency gas burners and gas appliances for all purposes.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Leaflet containing a summary of a test on the Allis-Chalmers 10-inch single-stage centrifugal pump, which gave an efficiency of 85 per cent.

Schum Bros., Metropolitan Bldg., New York City. Circular advertising Schum automatic nut locks, the locking capacity of which has been increased from a quarter to a tenth turn of the nut.

J. M. Rogers Works, Inc., Gloucester City, N. J. Circular on the use and care of Rogers measuring appliances, illustrating limit gages, control gages, plug gages, snap gages and gages in sets.

Excelsior Tool & Machine Co., E. St. Louis, Ill. Circular descriptive of the Excelsior automatic grinding and polishing machine, which is a special machine with grinding capacity of 60 by 60 inches.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 48705 illustrating and describing direct-current motors and controllers for flat-bed and small rotary printing presses.

Joseph Dixon Crucible Co., Jersey City, N. J. Pamphlet containing suggestions on the proper care of belts, information on belt dressings, with directions for applying, and rules for calculating speed of pulleys.

Spaulding Print Paper Co., 44 Federal St., Boston, Mass. General catalogue, 224 pages, 6 by 9 inches, listing the company's line of drafting-room supplies, drawing materials, blueprint outfits, mathematical and engineering instruments.

Kingsford Foundry & Machine Works, Oswego, N. Y. Bulletin 17 of a compound Lancashire boiler and setting which provides for practically perfect combustion of fuel and enables bituminous coal to be burned without making black smoke.

Cowan Truck Co., 8 Water St., Holyoke, Mass. Catalogue describing Cowan transveyors and illustrating them in use in various plants. These transveyors are made in three types to handle loads of 3500, 5000 and 3000 pounds, respectively.

Davis Machine Tool Co., Inc., 307-313 St. Paul St., Rochester, N. Y., is issuing a table of fractional inch equivalents in decimals and millimeters, mounted on metal and reinforced with strawboard to withstand hard usage in shops, drafting-rooms, etc.

Marvin & Casler Co., Canastota, N. Y. Catalogue E illustrating the Casler offset boring head in operation on the turret lathe, drilling machine and milling machine. Specifications and prices are given for the various styles of boring heads and boring bars.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Catalogue descriptive of Blanchard high-power vertical surface grinders equipped with magnetic chucks. The various details of these grinders are well illustrated, making the construction very clear.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 8 describes the method of aligning the suspended type heading slide of the National heavy-pattern forging machine. Halftone and cross-sectional views make the description very clear.

General Electric Co., Schenectady, N. Y. Bulletin 46023 describing the G. E. arc circuit volt meter, which is a special instrument designed for testing direct-current series arc circuits. The approximate dimensions and the connections, together with prices, are included.

New Departure Mfg. Co., Bristol, Conn. Sheets 59 FE to 62 FE for looseleaf catalogue, treating of ball bearings in carver cotton seed huller; ball bearing installation in conveyor rolls; utility of ball bearings in electric hammer; and ball bearings in the pneumatic drill.

International Oxygen Co., 115 Broadway, New York City. Catalogue 3 containing a detailed description of I. O. C. bipolar oxygen and hydrogen generators. It is claimed that the chief characteristics of these generators are safety, reliability, and economy in operation.

Kennicott Co., Chicago Heights, Ill. Circular describing the Kennicott cycloid weir meter, which is particularly adapted for measuring relatively large quantities of water or for use wherever a limited amount of head room is available for the installation of an accurate meter.

Pajaro Mfg. Co., 1251 Brown's Ave., Erie, Pa. Circular of small magnifying mirror for toolmakers and machinists. The mirror is useful in cutting internal threads, setting forming tools and in many other operations requiring sharp eyesight and good light in situations difficult to illuminate.

Chisholm-Moore Mfg. Co., Cleveland, Ohio. Catalogue 24 containing 95 pages, 6 by 9 inches, on Cyclone chain hoists, trolleys, hand power traveling cranes, ammunition trolley hoists, malleable iron castings and shell tongs. The chain blocks, trolleys and traveling cranes of this line range from ¼ ton to 40 tons capacity.

Bacharach Industrial Instrument Co., Pittsburg, Pa. Leaflet descriptive of a new pocket CO_2 indicator for quickly and accurately determining the amount of CO_2 in flue and furnace gases. The instrument is made in a portable form so that it can be conveniently carried around and is always ready for use. A test takes about 2½ minutes.

C. & C. Electric & Mfg. Co., Garwood, N. J. Bulletin 101 descriptive of Type SL direct-current motors, built in all standard sizes from ½ horsepower up to 150 horsepower, for every variety of application. The bulletin describes the operating characteristics of these motors, and gives suggestions on the selection of the proper motor for varying conditions.

R. Martens & Co., Inc., 24 State St., New York City. Booklet on Russia and the vast opportunities for American trade there. Russia has a population of 180,000,000, and the potential market possibilities following the close of the war of this great population are enormous. The booklet contains much valuable information for manufacturers and others interested in foreign trade.

James Clark, Jr., Electric Co., Louisville, Ky. Catalogue 26 showing the line of "Willey" electric driven tools, dynamos and motors, which includes motor-driven hand drills, portable drills, portable

grinders, bench grinders, floor grinders, wet and dry grinders, buffers, hacksaws, sensitive drills, notching presses, winding machines, locomotive turntable motors and direct-connected motors and dynamos.

Emmert Mfg. Co., Waynesboro, Pa. Catalogue of the Emmert vertical or horizontal T-square, which comprises a combination of the usual type of T-square, scales, triangles and protractor. By the use of this instrument, much time can be saved in drafting work. The catalogue also describes Emmert drawing boards, which are so designed that they can be adjusted to any angle and slid toward or away from the draftsman.

Colonial Steel Co., 213 W. Lake St., Chicago, Ill., is publishing a stock list every two months, which lists all the standard sizes of the regular grades of Colonial steels carried in stock in the Chicago office, as well as grades that are not carried in stock. The booklets contain tables of information relating to tool steel and other interesting data. A complete list of the products made by this company is given on the inside back cover.

Rodman Chemical Co., E. Pittsburg, Pa. Booklet entitled "Casehardening," intended as a guide in the various operations of casehardening, and calling attention to an improved casehardening material—"Carbo" casehardening compound. The contents of the booklet are: heat-treatment of steel; casehardening; quality of steel; carbonizing material; apparatus; carbonizing operations; "Carbo" casehardening compound; condensed instructions.

Mark Mfg. Co., Chicago, Ill. Catalogue 12 on black and galvanized wrought pipe, line and drive pipe, well casing, irrigation casing, boiler tubes, electric wire conduit, cold-drawn steel unions, wrought nipples, drive well points, well strainers, pump — Artesian and tubular — well cylinders, tubular well valves and tools, pump leathers, pipe cutters, pipe vises, pipe threading dies and diestocks. The catalogue contains complete price lists of the product.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Treatise on "Nonpareil" corkboard insulation, used for cold storage warehouses, ice plants, dairies, creameries, refrigerators, etc. This piece of advertising literature contains 151 pages, 6 by 9 inches, and numerous illustrations. The valuable data on heat insulation makes the work of general interest to engineers, especially those who have anything to do with the conservation of heat or the exclusion of heat from rooms, etc.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Booklet giving compositions and physical properties of titanium aluminum and other standard bronze alloys. The alloys are distinguished by numbers, and photomicrographs of 20 and 200 diameters illustrate the structure of each. The book also contains a description of the methods used in making various tests, as well as tables of resistance and relative conductivity of various metals and alloys, physical constants, bearing pressures for various classes of bearings, etc.

A. S. Cameron Steam Pump Works, 11 Broadway, New York City. Bulletin 154 treating of Cameron centrifugal pumps. Sectional views illustrate both the single- and double-suction, open impeller types, and the booklet gives tables of capacities, speeds and horsepowers. Bulletin 110, covering the Cameron line of duplex pumps, which includes both piston and plunger types with single and compound steam cylinders for general service, boiler feeding, tank service, water works, hydraulic elevators, automatic pumps and receivers, brewery, quarry and mining work.

De Vilbiss Mfg. Co., Toledo, Ohio. Booklet H of the "Aeron" System of applying varnishes, enamels, first coats, lacquers and practically every kind of finishing material on wood and metal products with compressed air. The apparatus eliminates the hand brush from the finishing room. The company exhibited, at the Second Annual Industrial Safety Exposition of Ohio at Cleveland, in January, its exhausting equipment which insures complete removal of all fumes and vapors from the finishing room, thereby making for better sanitary and safer working conditions.

Garden City Fan Co., 1532 McCormick Bldg., Chicago, Ill. General catalogue 160 containing 148 pages, 6 by 9 inches, devoted to this company's line, which includes fans, blowers, heating and ventilating apparatus and air washers. The book contains tables of air pressure, temperature of steam at different pounds steam gage pressure, indoor temperatures under varying outdoor conditions, constants for heat transmission of miscellaneous materials with rules for applying, area and circumference of circles, allowable velocities of air through heaters, properties of air, and other useful information.

Greaves-Klusman Tool Co., Cincinnati, Ohio. Catalogue entitled "G-K Betterments" of engine lathes, heavy quick-change type and geared-head, single-lever control type. The company builds a complete line from 16 inches to 30 inches swing, and the 16-inch and 18-inch lathes are built with three styles of headstock as follows: four-step cone single back-gear, three-step cone friction double back-gear and geared-head, single-pulley drive. The 20-, 22-, 24- and 30-inch lathes are built in two styles as follows: three-step cone friction double back-gear and geared-head single-pulley drive. All sizes are built with quick change mechanism.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Catalogue DS 846 giving a complete list of the accessories used in pole-line construction, together with prices and dimensions. Catalogue IP 54, describing type CW slip-ring, induction motors for constant and varying-speed continuous-duty service. This motor is built in capacities from ½ to 650 horsepower, two and three phase, 25 and 60 cycles, 220, 440, 550, and 2200 volts. Leaflet 3763 of the Westinghouse 532-B railway motor; leaflet 3818 of Westinghouse type C push-button control stations for use with automatic motor starters and controllers of alternating and direct current; leaflet 3823 of commutating-pole rotary converters.

TRADE NOTES

Hess Steel Corporation, Bridgeton, N. J. has been absorbed by the Hess Steel Corporation, Baltimore, Md.

Continental Motor Mfg. Co., Detroit, Mich., has changed its corporate name to Continental Motors Co. No change has been made in the organization.

Hultberg-Johnson Tool Co., Inc., Jamestown, N. Y., was recently incorporated for the manufacture of tools, machinery and devices, with a capital of $25,000.

Advance Grease & Chemical Co., Jackson, Mich., has changed its name to Advance Grease Co. The company manufactures drilling and cutting compounds, lubricating greases and soap products.

Electric Controller & Mfg. Co., Cleveland, Ohio, announces that the net selling price of all E. C. & M. apparatus has been increased ten per cent because of the increased cost of manufacturing.

Hyatt Roller Bearing Co., Newark, N. J., announces that owing to advances in the cost of raw materials used in the manufacture of Hyatt flexible roller bearings, it has been necessary to raise its prices.

Cleveland Twist Drill Co., Cleveland, Ohio, states that the publication in another technical journal of the notice of a fire in its plant was greatly exaggerated. It did have a fire, but only a small outhouse or shed was partially burned.

Lober Art Brass & Specialty Co., 124-130 11th St., Toledo, Ohio, has recently moved into its new building, which has a floor space of 6000 square feet. The company makes a specialty of steel spinnings and is giving regular employment to twenty-four metal spinners. A stamping and plating department has been added to the plant.

American Machine Co., Newark, Del., builder of improved Rider & Ericsson hot air pumping engines and the Denny tag machine, has sold its entire capital stock, factory and equipment to the Titan Motor Car Co. The business will be continued as a department in connection with the production of the Titan steam motor cars, under the original name.

Stow Mfg. Co., Binghamton, N. Y., manufacturer of the Stow flexible shaft, has made arrangements with the American Express Co. by which customers in foreign countries may place orders with the American Express Co. for transmission. These orders will be transmitted directly by the express company and no buying commission will be charged.

Electro Dynamic Co., Bayonne, N. J., maker of interpole motors, has placed a contract with the John W. Ferguson Co. for the erection of an addition to the plant approximating 100 feet square. The building will be one story high with mezzanine galleries and will be built on the regular mill construction lines with brick walls and a felt and slag roof.

Ward-Leonard Electric Co., Mount Vernon, N. Y., originator of the electrical control system bearing its name, has let a contract for a two-story factory to be located at the corner of Pearl and South Sts., Mount Vernon, to John W. Ferguson Co. of New York. The building, measuring 83 by 153 feet, will follow regular mill construction lines, and will be covered by a slag and felt roof.

Allied Machinery Co. of America, 120 Broadway, New York City, has been purchased by the American International Corporation, which proposes to extend and develop the business. The Allied Machinery Co. was capitalized at $200,000 and was formed about four years ago by interests connected with the National City Bank of New York City, for the purpose of promoting the sale of American machine tools and machinery abroad.

Cowan Truck Co., 8 Water St., Holyoke, Mass., builder of transveyors, has acquired a site having a frontage of 265 feet and a depth of 222 feet. A contract has been let for the erection of a two-story building 100 feet wide by 200 feet deep, affording about 40,000 square feet floor space. The building will be of concrete and brick with foundations designed to support three additional stories. The Cowan shop transveyor was awarded a gold medal at the Panama-Pacific International Exposition.

Curtiss Aeroplane & Motor Corporation, 65 Churchill St., Buffalo, N. Y., incorporated in January, has taken over the assets and property, and assumed the debts and liabilities of the Curtiss Motor Co. The business formerly conducted by the Curtiss Motor Co. will be conducted by the Curtiss Aeroplane & Motor Corporation. The corporation has a branch office and plant at Hammondsport, N. Y., and the subsidiary company—the Curtiss Aeroplane Co.—also has offices at Hammondsport, N. Y., and Buffalo.

Landis Tool Co., Waynesboro, Pa., which has sold its grinding machines direct in the West, has severed its connection with the W. H. Foster Co. and has now made arrangements to handle its sales direct in the eastern territory also. A. G. Nevin will represent the company in New York state and eastern New Jersey; M. G. Dunbar in the New England states, and T. M. Scherer in western New Jersey, Pennsylvania, Maryland and Delaware. An office will be opened by the company at 50 Church St., New York City.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, builder of lathes and milling machines, has broken ground for a new plant located on Madison Road not far from Oakley, a suburb of Cincinnati. The new plant will afford 600,000 square feet of floor space and will be on a plot of land covering thirty-eight acres. A separate office building will be erected. The present intention of the company is to build lathes exclusively in the new plant and utilize the plant on Eastern Ave. for the manufacture of milling machines.

J. N. Lapointe Co., New London, Conn., manufacturer of broaching machines and broaches, will resume work, which was stopped in February, on a new three-story building 50 by 140 feet, as soon as the weather conditions permit. The construction will be of stone, brick and concrete. The new office will be located in this building. The company has started the construction of one additional story on the two-story building completed last year, converting it into a three-story building. The structure will be extended 27 feet in length.

Harrison Safety Boiler Works, 17th St., and Allegheny Ave., Philadelphia, Pa., was awarded the gold medal at the Panama-Pacific Exposition for its exhibit of the combined open feed water heater and hot water meter, known as the "Cochrane" metering heater. This apparatus is designed to heat boiler feed water by means of exhaust steam from engines, pumps, etc., and simultaneously to meter the water and record the rate of flow and to integrate the total flow in any elapsed period. This enables the engineer or plant owner to determine how many pounds of steam are being evaporated per pound of fuel burned under the boilers and hence to compare the different fuels, methods of firing, etc.

American Foundry Equipment Co., Cleveland, Ohio, manufacturer of the Wadsworth direct-pressure system sandblast apparatus, and the Sand Mixing Machine Co. of New York City, manufacturer of the "Auto" sand cutting machine, have combined interests and moved into a new and up-to-date factory at 1111 Power Ave., Cleveland. H. L. Wadsworth, inventor and designer of the "Wadsworth" sandblast apparatus, is factory manager in charge of all departments. Charles L. Benham, an old employe of the Sand Mixing Machine Co., will be in charge of affairs as factory superintendent. The executive offices of both concerns will be maintained at 52 Vanderbilt Ave., New York City, in charge of V. E. Minich, vice-president and general manager.

Wagner Electric Mfg. Co., St. Louis, Mo., has begun the construction of two new buildings on Plymouth Ave. Building No. 1 is 140 by 90 feet with an open bay 50 feet wide spanned by a traveling crane, with galleries 20 feet wide on each side. This building will be devoted to punch press operations. The framework will be of structural steel, with an all metal roof having a longitudinal skylight down the center. Building No. 2 will be 90 by 106 feet, and will be devoted to various operations involving the production of small parts, including small punch press work. This building is of reinforced concrete construction and fireproof throughout. The reinforced floors of concrete in building No. 2 will be built under the "Acme" system of the Condron Co.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., maker of drop-forgings, has placed with John W. Ferguson Co. a contract for several additions to its Buffalo plant. The drop-hammer shop addition will be the largest, consisting of four bays giving additional space of 64 by 310 feet. The construction will be similar to that of the main building—a structural steel frame with exterior walls of brick, steel sash and a gypsum slab roof, using the "Metropolitan" system. There will be no floor. The stock and finishing building will have its floor space increased by five bays, 82 by 80 feet, and the construction of this addition will be similar to that of the hammer shop. The roof, however, will be of the sawtooth type; a maple floor will be laid.

Hoover Steel Ball Co., Ann Arbor, Mich., will double its entire plant this year; the new buildings will afford approximately 42,000 square feet additional floor space, making a total of about 84,000 square feet of manufacturing floor space in the entire plant. The machinery and equipment have been ordered for the new buildings, and it is expected that the entire addition will be in operation by October 1. Business has been increasing so rapidly during the past eighteen months that the company has orders booked ahead for a year or more. With the new equipment installed the production will be from 25,000,000 to 30,000,000 balls a day, and 350 tons of steel will be used in the manufacture of balls monthly. All the new buildings will be of fireproof construction, as they are being built of concrete and brick.

Davis-Bournonville Co., New York City, manufacturer of oxy-acetylene and oxy-hydrogen welding and cutting apparatus, announces several changes and additions in its selling organization. W. R. Noxon succeeds W. S. Schoenthaler as manager of the Chicago office. Mr. Schoenthaler goes to the company's general offices in Jersey City. H. H. Armstrong was recently appointed district sales manager of the Pittsburg district. The Pittsburg sales office and demonstrating plant has been removed to 316 Penn Ave. A demonstrating plant and commercial welding department has been established at 147 W. Austin Ave., Chicago, in charge of F. J. Maeurer. Mr. Maeurer was formerly superintendent of the welding department at the Jersey City shops, and he was succeeded by H. Ulmer as superintendent of the Jersey City welding department. John B. Redd, formerly with the Pacific Gas & Electric Co. and superintendent of the Collective Gas Exhibit at the Panama-Pacific Exposition, and George S. Pearson, recently with the American Stove Co. and superintendent of that company's exhibit at the Panama-Pacific Exposition, have joined the Davis-Bournonville sales organization. The company is now erecting a building at the Jersey City plant, which will give 40,000 square feet additional space and will provide for approximately doubling its production of apparatus.